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THE PRACTICAL ENGINEER

VOL. VII. Philadelphia, April, 1903. No. 3.

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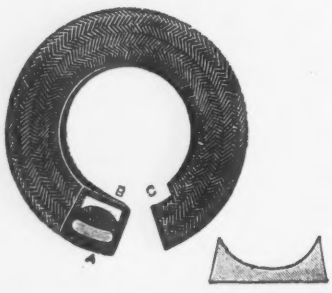

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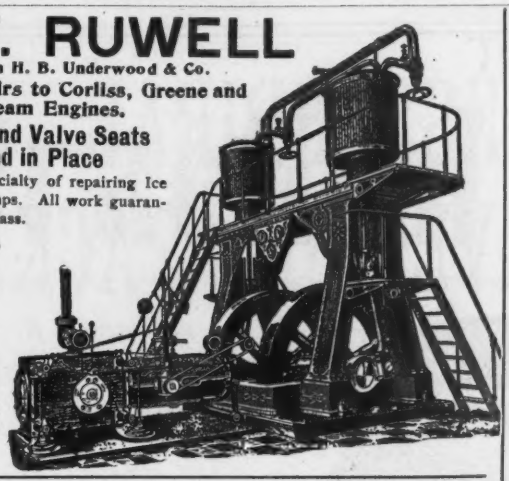

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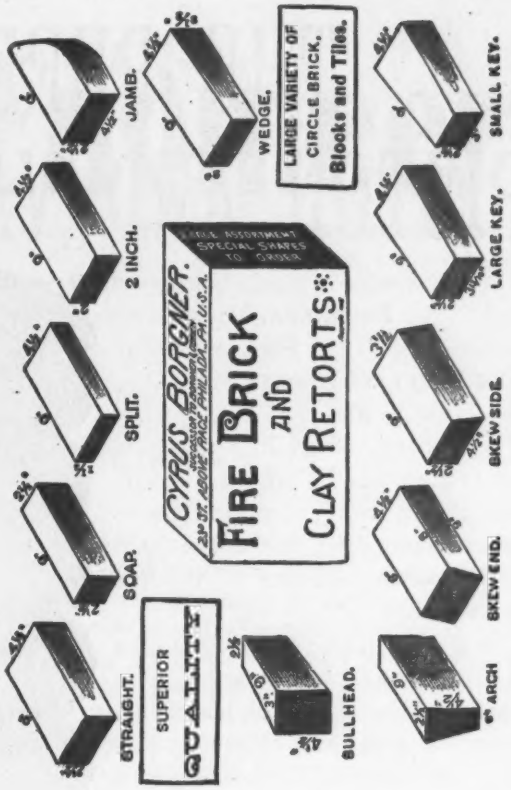

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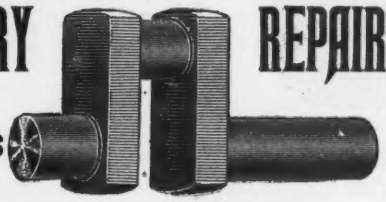

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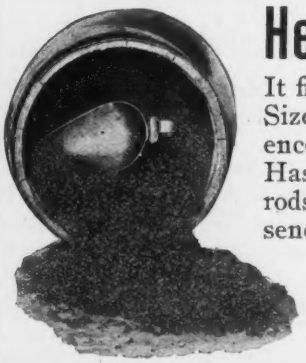

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The
Practical Engineer

A monthly journal, devoted to the economical generation and utilization of power and to the interests of stationary engineers

VOL. VII PHILADELPHIA, APRIL, 1903 No. 3

Some Electrical Fire Hazards

WASHINGTON DEVEREUX.

Read before the Engineers Club, of Philadelphia.

The subject that directs our attention is one of vast importance to all, regardless of whether they be the consumer or non-consumer, the lighting or power company, the telephone or telegraph company, or the insurance companies.

Not much has been written upon this subject excepting by the insurance fraternity, for, while the facts remain the same, the effect of stating the true condition of affairs would have discouraged many in the use of electricity as an illuminant or for power purposes. To-day the general public is better acquainted with the facilities afforded by the use of electricity and with the dangers involved in its abuse, and in consequence they assist materially in the advancement of this source of power. That this assistance may become of more value is most heartily looked for, and an examination of some of the causes that may create a fire from electricity may be the means of educating the public to this desired state. We may reduce the causes to:

1. Short-circuit, in which the current is impeded in its desired course.

2. A leak, in which the current flows over or takes an undesirable course.

3. The contact with parts which have become heated by the flow of current, which may be, at the time of heating, a part of the circuit from the source of supply to the consuming device.

The first cause, a short-circuit, may be defined as a circuit of low resistance. This definition is not self-explanatory, for we may have a low resistance, which resistance could be made up of any number of resistance devices connected in multiple and doing useful work, the joint resistance of which may be very low.

To enlarge upon the previous definition, we may clearly define a short-circuit as a circuit of low resistance by which the current is impeded in its desired course, and from which we derive no benefit.

The second cause, a leak, may be of high or of a comparatively low resistance. In either case it must be treated as an undesirable consuming device attended with its many dangers.

The third cause does not require any further explanation, for our daily experience with heat from any cause, and its effect upon bodies in contact with it, is the best demonstration of its danger.

Before examining the causes denoted, it may be well to bear mind that any one of the causes may occur in any part of the circuit, which circuit involves any part of the generation, the transmission, or the translating of electric current.

The most simple case of a short-circuit is that in which two wires of the same circuit and of opposite polarity, and between which a difference of potential exists, are brought into electrical contact. The result of such contact is to allow an amount of current to flow sufficient to melt the fuse or to open a protecting device, or to heat the wire to its melting-point.

It may be readily seen that a short-circuit can occur in any part of a circuit, which circuit has been defined, irrespective of the difference of potential.

Experience has shown us that in the majority of cases the protecting devices, by which is meant the fuses and circuit breakers, will be affected and will open the circuit, but it seldom occurs until after the damage to the troubled part is effective.

We see examples of the effect of a short-circuit in which the generator, the storage battery, the switchboard, the line, the transformer, the motors, the lamp, and the operating and protective devices have been destroyed beyond repair and in some cases beyond recognition.

Several large central station fires have occurred primarily due to a short-circuit. One case worthy of mention is that of a lighting station in which an arc started at the bottom of the alternating switchboard, simultaneous with a short-circuit of an alternating generator.

An effort was made by the attendant to disconnect the exciters and the alternator from the circuit, but the effort proved futile, owing to the great heat attending the arcing which had spread over the entire board. In an instant the other alternators were short-circuited and the station doomed to destruction.

Another case is that in which a chain hanging from a crane made contact with the exposed live parts of a trolley power generator, causing a short-circuit. The heat attending the short-circuit was sufficient to melt the metal, which dropped to the floor, resulting in quite a disastrous fire. From the same cause we find the destruction of motors, irrespective of the source of supply or of the nature of the work to which they may be applied; of incandescent lamps due to the crossing of the filaments, the connecting wires, or the base of the lamp; of arc lamp on low-potential systems; of sockets, switches, cut-outs,

flexible cords, wiring on gas and electric fixtures, each of which may result directly in a fire.

The second cause, that of a leak, is possibly one of the most treacherous factors we have to contend with.

A leak, resulting in the flow of a current, may be so small that it will not affect the smallest protective device on the line. Its work is slow and in almost every case destructive, and does not necessarily appreciably heat the wire unless the line is excessivəly fused, in which case there may be an excessive flow of current.

This leak can exist at any peint and is usually due to dampness; it is difficult to test for and locate, as its condition varies with atmospheric changes or other causes that may vary the moisture which may exist on any insulating material.

When due to dampness, this leak is the result of a combined electrochemical action, which we know is attended with more or less heat.

The process of electro chemical decomposition may be more correctly termed electrolysis. Unless interrupted, its ultimate end is to destroy the insulating properties of substances that are in contact.

A case in point is that of the charring of wood molding directly the result of dampness, in which there is a surface conduction of current. This will eventually change the wood into a more combustible substance—that of charcoal. Being a comparatively good conductor of electricity, the current flowing may be sufficient to heat and ignite the charcoal, or it may be ignited by an arc.

This electrolytic action affects metallic substances wherever encountered. In many cases the so-called verdigris, a direct result of electrolysis, covers switchboards, switch bases, and cut-outs, rendering this otherwise insulating surface a conductor of electricity, further increasing the action and heating the affected parts. Sufficient heat may and has been developed to rupture the insulating base, consisting as it may of either slate, porcelain, or marble, and permitting the actual contact of the switch blades or fuse lugs resulting in a short-circuit.

Electrolysis acting upon conductors will eventually reduce the cross-section of the conductor to such a small area that it is no longer safe to carry the normal current. In some cities considerable damage has resulted from underground electrolytic action, namely, the decomposition of water and gaspipe lead armor of telephone and telegraph cables.

Probably the most favorable condition for electrolytic action in connection with interior wires is that in which two wires of opposite polarity are incased in wood molding, each wire being properly located in its own groove and the molding properly capped. By means of a mop or broom the molding near the washboard is sprayed with washing-water which is more or less impregnated with alkalies. The surface of this molding then becomes an excellent conductor of electricity, and the result is that which I have already explained.

In another instance electrolytic action set in between conductors incased in an iron conduit (unlined) and was carried to such an extent that the insulation broke down, causing a short circuit, welding the conductors and puncturing the conduit.

Grounding will eventually produce the same condition of affairs. By grounding is meant that there is an electrical connection between a conductor and the earth, or between the conductor and some conducting material that may be partially insulated from the earth. In either case, intended or not, there is a difference of potential between the insulated conductor and the earth, or between the partially insulated material and the earth. The accidental grounding of the other side of the circuit will produce a leak or short-circuit, inviting an undesirable condition.

In one instance, a frame house supplied with gas, was wired and connected for the supply of electric current. A flexible drop cord was hung in front of a bureau between two windows. A gas bracket was located beside one window, the pipes to supply the brackets being run under the window, but inside the framework, a joint in the pipe being made directly under the window. A fire occurred and an examination justified the following conclusions: The flexible cord had been hung over the gas bracket the handling of both the cord and the bracket had resulted in the removal of some of the insulation of the cord, thus making an electrical connection between the gas-pipe and the bare wire; the current was carried to the gaspipe joint; the contact, being electrically poor, created an arc, punctured the pipe, and ignited the gas. Another example is a case of a poorly grounded conduit system in which either positive or negative wires became grounded to the iron conduit, and in which event the conduit becomes of the same polarity as the grounded wire, and there will then be a difference of potential between the grounded pipe and the earth, or the other polarity of the system, ever ready to close the circuit, creating a cross, or short-circuit. The same condition is possible in metal ceiling construction.

On very large systems, as for example a three-wire underground system supplying current over a large district, it is impossible to maintain a perfect freedom from grounds, the leakage to earth being through the insulation and the tubes, the service, junction, and feeder boxes. On such a system it is practically impossible to make use of a ground detector, on account of this leak being general. Such a ground or leak practically connects every underground pipe service to this system.

In connection with the supply of current to combination gas and electric fixtures, where it becomes necessary to attach the wires to the gas-pipes, it would be dangerous, if not disastrous if the insulation should break down, piercing the gas-pipe and igniting the escaping gas. It may be well to note here that trolley systems have a ground return and maintain a difference of potential of about 550 volts between the trolley wire and the rail.

The high-tension series arc light system, whether underground or overhead, furnishing a constant current of 9.75 amperes, the potential of which may vary from 500 to 6500 volt is a source of danger, for, in the event of two grounds, the arc produced may be a powerful one and, should a break occur in the line, an intense and a long arc may be obtained at that point

If the primary and secondary coils of a transformer come into contact electrically, the high-voltage primary current would flow to the secondary system, which is entirely unsuited to such high pressure.

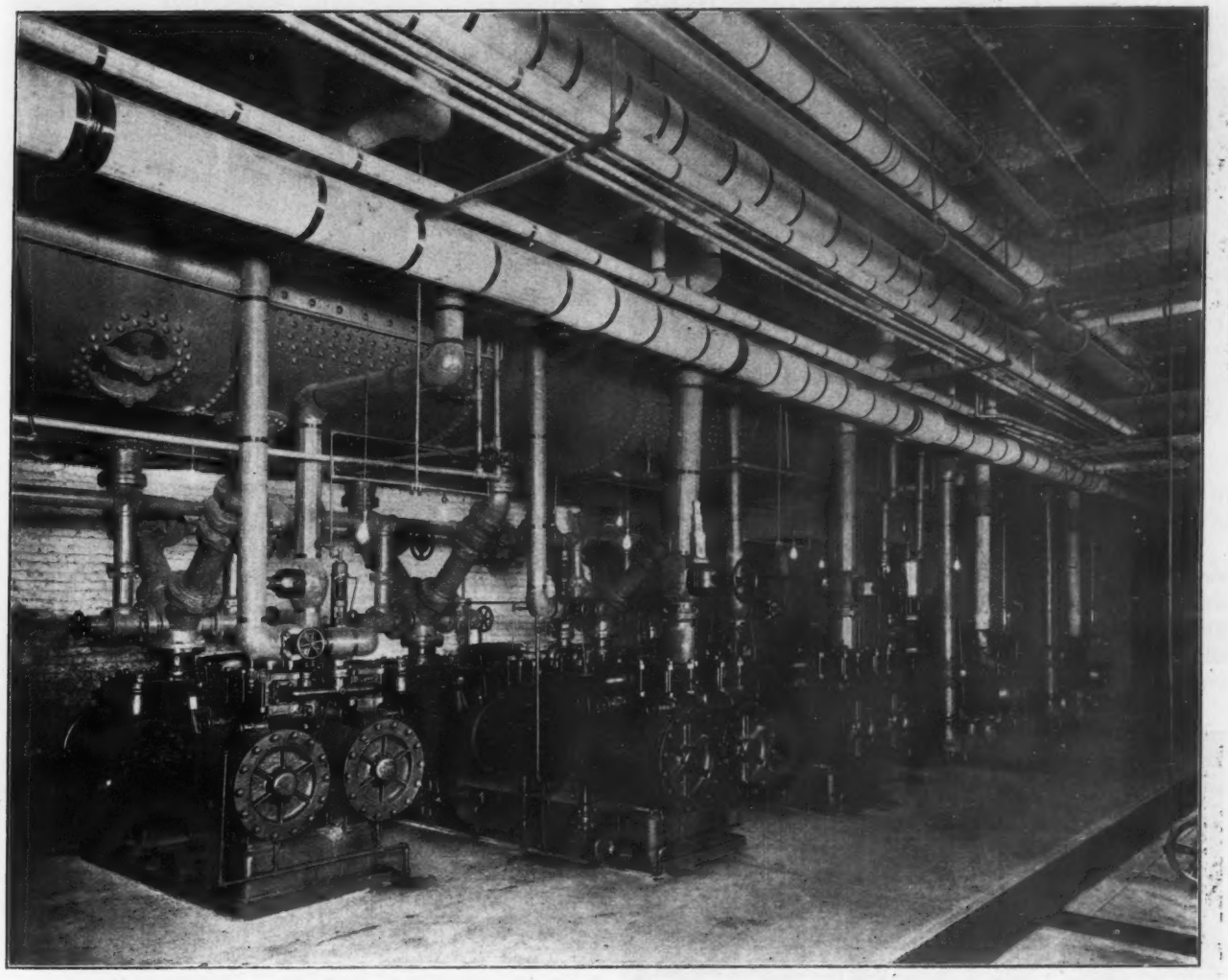
There is still another hazard in connection with overhead lines—that of discarded wires. These wires, no longer in service, but retained in order to maintain the right of way, cross and lie upon roofs of buildings or hang in an unsafe condition from a structure, and in some cases, such as telephone, telegraph, and call wires are, actually connected to gas and water-pipes in tenanted or unoccupied buildings. The other end of these discarded wires may be hanging promiscuously and

possibly, due to corrosion or rusting of the wire or its holdings, fall and cross wires carrying current at a high or low voltage. In consequence, the current is carried through the discarded wires to ground, whether it be gas or water-pipes, metal roofs, cornices, or awnings, and may be sufficient to melt the wire or cause an arc at some comparatively high resistance point, creating a most favorable condition for far more serious trouble.

Continued next month.

box into the cylinder, the pressure, 120 pounds, being exerted directly on the end of the plunger. The weight of the platform and plunger is partly counterbalanced by weights attached to the platform by a skeleton framework by means of wire ropes.

Power for the elevators is furnished by two 14 by 20 by 11 by 15 compound duplex and one 17 by 11 by 15 duplex steam pumps, either one, or all, of which may be used. These pumps discharge into two pressure tanks 54 inches diameter and



Elevator Tanks and Pumps at Merchants Warehouse, Philadelphia.

A Neat Steam Plant

On Delaware Avenue, below Chestnut Street, Philadelphia, is a massive looking seven-story building, known as the "Merchants' Warehouse," having about 235,000 square feet of floor space, devoted to the storage of general merchandise. Two railroad sidings, extending through the building, together with the fact of its being directly on the river front, afford every facility for the receipt, assortment, and disbursement of merchandise in enormous quantities.

Communication with the upper floors is provided for by fourteen, two ton hydraulic elevators; these are of the "plunger," or "direct lift" type, the plunger or "ram" being connected direct to the under side of the platform and passing through a stuffing

twenty feet long, supported on a structural iron framework directly over the pumps and connected so that either one, or both, may be used as may be required. A Westinghouse air compressor furnishes the necessary air for the pressure tanks.

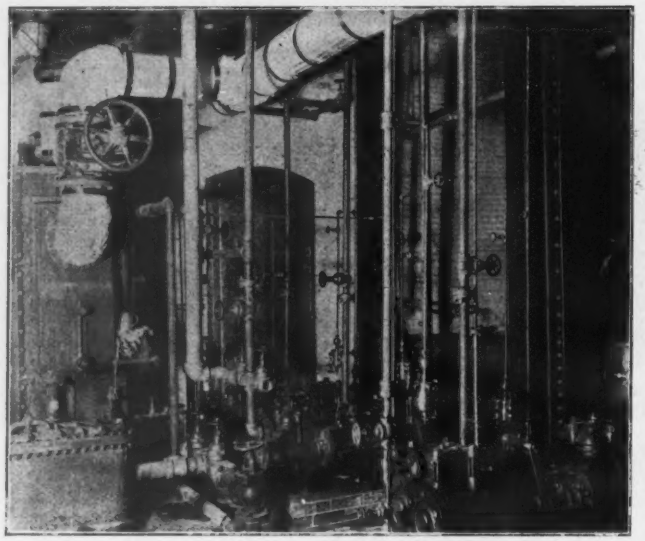
The discharge from the elevator cylinder is received in a ten thousand gallon tank, standing on the floor beside the pumps.

For lighting the building a duplicate generating set is employed, each set consisting of a 9 by 12 Buckeye engine, direct connected to a 30 K. W. 110 volt Lundell, four pole generator.

Steam is furnished by two one hundred and fifty H. P. National Water tube boilers, operating at a pressure of 125 pounds. Each boiler has a steam drum 32 inches diameter by 18 feet long, 4-inch by 18 foot tubes, and 45 square feet of grate

surface. The firing is done by hand, anthracite coal being used for fuel.

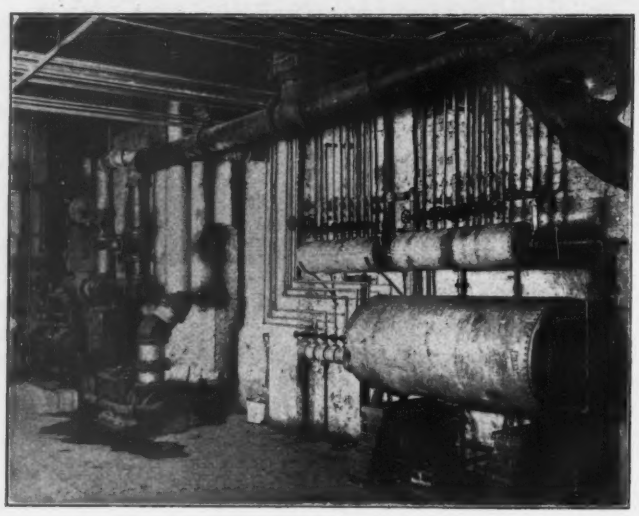
Feed water is supplied to the boilers from a 350 H. P. Cochrans heater by means of 5½ by 3½ by 5 duplex pumps in duplicate. Two 6 by 4 by 6 duplex steam pumps keep the building



Boiler Feed Pumps

free from surface water, all of which is collected in four wells, from which it is pumped into the sewer.

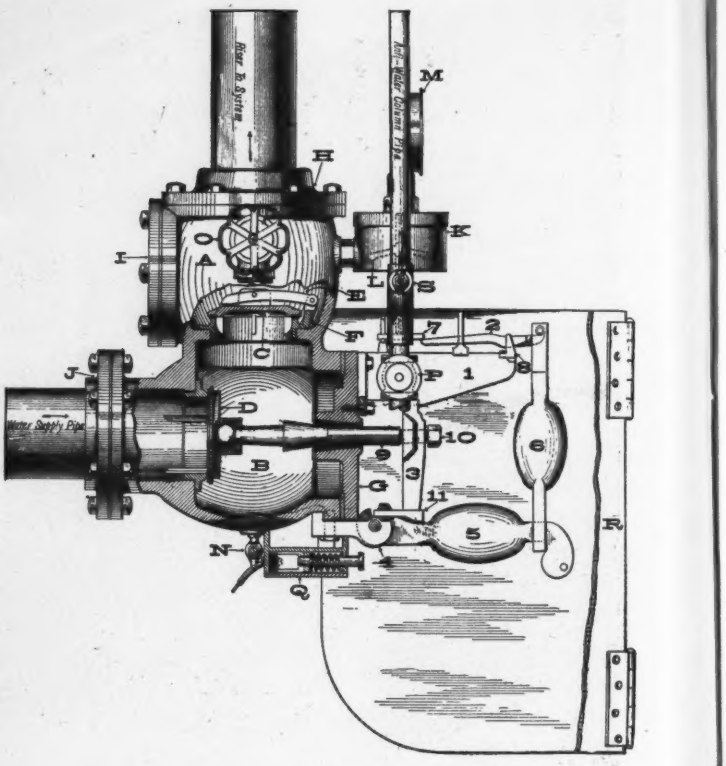
The offices throughout the building are supplied with hot water from a generator, shown in the illustrations. This consists of a tank, in which a steam coil is placed, and the supply of steam controlled by a thermostatic valve. The water supply to each floor is independently controlled from the generator, and a constant circulation maintained in the system insures hot



Hot Water Heater

water the instant the valve is opened. All service water for the building, both hot and cold, is supplied from a ten thousand gallon tank in the tank house on the roof.

In this house, also, are located three ten thousand gallon fire tanks, supplied by a 16 by 9 by 12 duplex underwriter's pump, with a capacity of 750 gallons per minute, and under automatic control. Twenty-seven hose outlets are distributed throughout the building, and the opening of any one of these starts the pumps. In addition to the hose connection, there are 4500 sprinkler heads, each floor being under separate control. The main supply pipe from the tanks is brought down to the engine room; on the fourth floor, four branches supply the sprinklers on the upper floors, and the lower floors are supplied through branches from the engine room. In each branch is a check with an electrical attachment. This check, normally, remains closed but in the event of a sprinkler head opening, the flow of water opens the check, thereby closing the contacts in the electrical device, in the circuit of which is a ten-inch vibrating stroke bell. All of these bells are assembled on one board in the engine room; a glance will tell upon which floor a sprinkler is in operation.



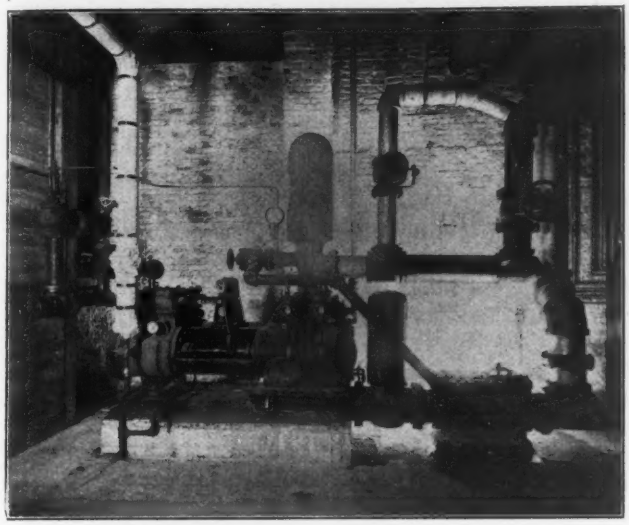
Automatic Check Valve

Upon this same board, are the pressure gauges, one connected to the supply of each floor showing the pressure maintained.

During the winter, when there would be liability of the water freezing in the pipes, the sprinkler system is drained, and an air pressure of thirty pounds is maintained by two Westinghouse air compressors. The water is held back from entering the branches supplying the various floors by a valve on each branch. This valve, as shown in the illustration, is held closed by a system of compound levers and a latch, which latter is held in place by means of the air compressor. In the event of a sprinkler head opening, this pressure falls, thereby releasing the latch, and the water pressure opens the main valve, admitting water to the sprinklers on that branch.

The plant is in charge of Mr. H. P. Rockwood, whose office at the entrance to the engine room is unique from the fact that its

wall decorations consist of a very complete assortment of tools of all sizes and descriptions, suitable for engine room use, all



High Duty Fire Pump

symmetrically arranged, and covering nearly three walls of the room from floor to ceiling, exemplifying to a nicety the old saying, "A place for everything, and everything in its place."

✤ ✤ ✤

Some Queer Ideas in Boiler Practice

BY R. T. STROHM.

It is said if a man habitually and persistently tells untruths, there comes a time when his oft-repeated misstatements become actual truths in his mind. This doubtless due to continuous repetition. And it is this same process of repetition, perhaps, which has handed down a number of fallacies concerning the steam boiler upon which the stamp of apparent reliability has been set.

One of the first of these long-standing errors is that which concerns the effect of boiler scale upon the transmission of heat from the furnace gases to the water inside the shell. The statement has been made, and is to be found in more than one handbook or publication intended for engineers, that boiler scale has a marked effect in lowering the efficiency of the boiler because it retards the passage of the heat from the furnace to the water. This is true to a certain extent. But when the statement goes further and declares that a layer of scale one-sixteenth of an inch in thickness requires an outlay of twenty per cent. more heat, and that a lining of scale one-eighth of an inch thick necessitates forty per cent. more fuel to accomplish the same evaporation, then the statement goes beyond the bounds of belief.

For there are many boilers in actual service at the present time with scale from one-sixteenth of an inch to one-eighth of an inch in thickness on their water surfaces, and yet it cannot be found that these boilers are using from 25 to 30 per cent. more fuel than when they were installed. Or, at least, if they are using such extra quantities of fuel, the cause cannot be definitely traced alone to the existence of scale on the heating surfaces.

The rate at which heat will be transmitted through any conductor will be proportional to the thickness, but the conductivity of all substances is not the same. And where two different substances, of different thermal conductivities are placed in contact, as is the case when the scale adheres closely to the shell, then the question becomes quite complex.

A thin scale of less than one-sixteenth inch will have little effect upon the heat transmission. As the thickness of the scale increases the efficiency of the conduction is lessened, and the fuel consumption for a given duty somewhat increased, but not, however, in any such exorbitant ratio as that cited in a previous paragraph. It is extremely doubtful, indeed, whether any definite rate of loss can be fixed, for the reason that scale varies in texture and composition.

In spite of this, however, it must be remembered that a clean plate is always the best for the transmission of heat. And, furthermore, the collection of scale to any considerable extent is detrimental, not so much because of the effect upon the efficiency as because of the danger of overheating the plates, causing them to bulge, loosening the joints and tubes, and damaging the boiler generally.

Another belief which has secured quite a strong hold upon engineers is that black smoke, issuing in volumes from the chimney, denotes a large waste of fuel. And considering this as a fact there are many who would put forth supreme efforts to effect economy in fuel consumption by the prevention of smoke.

Even the blackest smoke contains only a small percentage, by weight, of the carbon in the coal. Smoke is nothing more or less than finely divided carbon which has become chilled during the process of combustion to such a degree that combination will no longer take place, thus leaving the unconsumed carbon in the gases. The amount of this carbon, however, is really very slight.

A very small quantity of indigo will impart a deep blue color to a large volume of water. In the same manner, a small quantity of free carbon will give a very dark color to a large volume of flue gasses, but the heat loss due to this carbon will be of such small amount as to make no serious item into heat-balance.

"But, if this is true, why is it that smokeless combustion almost always shows greater economy in fuel consumption?" That is a natural question, which will doubtless flash at one into the mind of the reader. The answer is simple enough. Where conditions of smokeless combustion exist, there are to be found most of the other conditions which aid in making a plant more economical. So that instead of being attributable to the consumption of smoke, the saving is really due to the improved conditions of regular firing, uniform furnace temperature, proper air admixture, and so on. Indeed, it has been proven conclusively by actual tests that it is not economical to burn the smoke of a boiler. The cheapest and best way is to prevent its formation in the first place.

Similar to the above belief, and quite as untenable, is that which places credence in the statement that there is any considerable loss in the steam boiler due to the escape of carbon monoxide in the flue gases.

It is true that the presence of carbon monoxide or CO means incomplete combustion, and incomplete combustion entails a heat loss. For, a pound of carbon burned to carbon dioxide yields 14,600 heat units, whereas the same weight of carbon burned to the monoxide would develop less than one-third as many heat units. Hence, any considerable percentage of CO in the flue gases would mean a large heat loss. However, when boilers are in active service under good working conditions,

there is a very small amount of carbon monoxide passing into this chimney. Repeated tests have shown it to average less than one per cent.

Where the boilers are fired very rapidly, however, bringing about the condition of forcing the boiler, then the formation of CO is greatly increased and may reach extremely wasteful proportions. Forcing the boiler, which is in reality forcing the fire, means the burning of a greater amount of coal per square foot of grate area per hour than that at which the boiler will work most economically. When the fuel is ignited throughout the entire bed, then the air supply can be reglated to give complete combustion, with the least amount of air. When fresh coal is suddenly thrown on the fire, the fuel bed is thickened appreciably, the passage of air through the burning coal is rendered more difficult, and as a consequence there is not air enough admitted to completely burn the free carbon, and carbon monoxide is formed. Where the fires are severely forced, the amount of carbon carried away as CO may amount to as much as 50 per cent. of the total carbon in the fuel. This would mean an enormous loss of heat, and is a strong argument against excessive firing. But in ordinary cases, where the boiler is worked at or near its proper capacity, the amount of carbon lost by imperfect combustion will be comparatively small, and will probably average less than 1.5 per cent of the total carbon in the fuel.

Another fallacy is that the amount of heating surface necessarily forms a measure of the boiler capacity. Within certain limits this is doubtless true enough. Many makers of steam boilers rate their boilers by the horse-power, allowing from 12 to 15 square feet of heating surface to represent one boiler horse-power. According to such a method of rating, the boiler with the greatest amount of heating surface would have the highest standing and should show the greatest evaporation. But this is not borne out in practice. There is a limit to the extent to which the heating surface should be carried, and, furthermore, the location and arrangement of the surfaces has a great deal to do with the efficiency and the capacity of the boiler.

Thus, it would be possible to so far increase the heating surface of the boiler as to have the gases enter the chimney at the initial temperature of the feedwater. But this would necessitate a much greater expense in the construction of the boiler, increased cost for the setting, a larger loss due to radiation, the use of artificial draft, and greater expense for clearing and repairs.

It is well known that some parts of the heating surface of a boiler are very inefficient as far as the conduction of heat is concerned. The lower rows of tubes in a return tubular boiler are examples of inefficient heating surface. In some tests, the plugging up of these tubes did not affect the evaporation to any appreciable extent, and we may conclude from this that they aided little or not at all in causing evaporation.

On the other hand, those surfaces which receive the radiant heat from the bed of fuel on the grates form the very best portions of the heating surface. And, likewise, those surfaces which are placed at right angles to the current of gases will transmit more heat than those whose direction is parallel to the flow of the gases. The fact that most tubes of water tube boilers are placed directly across the path of the flue gases is one good reason for the excellent evaporative results usually obtained.

There are no doubt many engineers who have seen the experiment which shows that flame under ordinary conditions will not pass through fine wire gauze or netting. The experiment consists in holding a piece of wire gauze a few inches above a gas jet from which gas is issuing. If the gas be lighted above the gauze, it will continue to burn on the upper side of the netting, but it will not pass through to the jet on the under side. Because of this, it has come to be accepted by some that the flames from a boiler furnace will not pass through the tubes of the boiler. Such an idea is erroneous. If the fuel used is rich in volatile matter, and the draft is strong, the flames may extend not only through the tubes, but even into the chimney. The flame in the experiment mentioned above can be made to pass through the gauze under the effect of a strong air current downward.

Boiler explosions whose causes are not directly ascertainable form a wide field for the exercise of a vivid imagination and the promulgation of fantastic theories.

One explanation of an explosion, as set forth by an engineer, was that the water in the boiler had lifted from the plates, and that then the shell became so overheated that when the water again came into contact with it the sudden generation of steam caused the increase of pressure to which the explosion was due. Now, it is true that when water is poured on a red hot plate it will resolve itself into numerous spherical particles which will roll around until entirely evaporated. And it may be noticed, too, that these globules do not touch the plate, being separated from it by a thin film of steam. Everyone who has chanced to spill water on the top of a hot stove has noticed this phenomenon. But to apply the same conclusions to the steam boiler does not appear reasonable. In the first place, the water has been in continual contact with the shell and it is hard to understand how any increase of heat can be so sudden as to change the lower film of water to a film of steam which would keep the water from touching the shell. Again, the volume of the water in the boiler exerts a considerable pressure due to its depth and it is dfficult to realize how this weight can be lifted and held away from the plate until the latter becomes so overheated as to be weakened.

Another explosion which occurred some years ago brought forth quite an ingenious explanation from the engineer, the only one of the managing force of the plant who escaped. It seems that for a long time zinc had been used in the boiler to prevent incrustation and corrosion. But this proving only partially effective, the engineer began to use kerosene. The explosion occurred very soon after the use of kerosene had begun. The engineer explained the cause of the disaster in this manner.

First of all, he argued, the kerosene was decomposed by the heat into a highly inflammable gas. Furthermore, there was a certain electrical action between the zinc and the iron of the boiler plate. This electrical action in some manner produced a spark, which at once ignited the oil gas, and thus burst the boiler.

Now, how this electrical spark could be produced with a closed circuit and no probable way of breaking it, is a mystery as yet unsolved. Also, the gas could not possibly burn or explode unless mixed with oxygen. And the small quantity of air which comes into the boiler in the feedwater would never be sufficient to form an explosive mixture with the gas. Last of all, it is not by any means clear just how the oil gas collected in

any great quantity in the boiler, since its specific gravity is considerably below that of steam, and it should therefore pass out more readily than the steam. On the whole, the theory is remarkable not only for its ingenuity but quite as much for its improbability.

The Production of High Temperature

BY T. H. REARDON.

The calorific power of a fuel, or the quantity of heat evolved when a definite weight of any particular substance is burned, is always a constant quantity, and it is entirely independent of the rate at which combustion proceeds. Every pound of carbon burned to carbon dioxide evolves 14500 heat units, and it is wholly immaterial whether the combustion takes place in the fraction of a second, as in the discharge of a cannon or whether it occupies years, as in the decay of a fallen tree, the calorific energy liberated is precisely the same in amount. The flash and explosion leave on the mind the impression of a vast expenditure of energy; yet in the decay of the fallen tree the same amount of energy is liberated, but so slow that it is dissipated, unnoticed. The time in which combustion takes place is very important in its bearing on some particular matters. For some particular purposes, metallurgical operations, for instance the realization of a very high temperature is absolutely essential; and the question at once arises as to how fuel shall be utilized to attain this end, and also what particular fuel shall best meet the requirements. When carbon is burned to carbon dioxide, 14500 heat units are evolved for each pound burned, a quantity of heat sufficient to raise the temperature of 14500 pounds of water 1 degree, or to raise the temperature of 1 pound of water 14500 degrees. It is obvious that the highest possible temperture will be obtained if the total amount of heat evolved is used solely for elevating the temperature of the products of combustion, and that there is no loss by conduction or radiation. The specific heat of carbon dioxide is .2164; from this it follows that one heat unit will raise the temperature of 1 pound of carbon dioxide 4.62 F.; but in the combustion of one pound of carbon, 3.67 pounds of carbon dioxide are formed. Now, if the 14500 heat units are used solely for the purpose of raising the temperature of 3.67 pounds of carbon dioxide, the highest possible temperature will be 14500 divided by 3.67 x. 2164 equals 18300 F. The heat produced by the combustion of one pound of hydrogen will raise the temperature of 62500 pounds of water one degree F.; but hydrogen requires for combination eight times its weight of oxygen, and produces in burning nine times its weight of watery vapor. Unfortunately, also, some of the heat evolved in the combustion of hydrogen is rendered latent in the formation of watery vapor, and the portion so lost is not useful in elevating the temperature of the products of combustion. This latent heat amounts to 966 heat units per pound of water formed. As nine pounds of water are formed by the combustion of one pound of hydrogen, 9 x 966=8694 heat units are absorbed and not usefully employed to raise the temperature of the products of combustion. Then we have 62500-8694=53806 heat units available for the elevation of temperature. The specific heat of steam is .475 and as nine pounds of steam are formed when one pound of hydrogen is burned, the highest theoretical temperature supposing no losses and that all the heat available is used solely for raising the temperature of the nine pounds of steam is evidently, $\frac{53806}{9 \times .475} = 12600$ degrees F.

Thus it will be seen that the attainable temperature only partly depends on the calorific value of the fuel, but it is dependent also on the nature of the products of combustion. The greater the quantity of combustible that can be burned in a given time and space, the higher the resulting temperature. In the preceding calculations of calorific power and intensity it has been assumed that the combustible was burned in pure oxygen, and that there was no waste of heat occurring through radiation or conduction and that the resulting heat was entirely employed in raising the temperature of the products of combustion. Pure oxygen is very rarely, if ever used as a supporter of combustion in practical operations, and therefore the diluting effect of the nitrogen by which oxygen of the air is always accompanied must be considered.

In all practical cases of combustion, the necessary oxygen is supplied from the atmosphere, which consists of a mechanical mixture of about 77% of nitrogen, 22% of oxygen and 1% of aqueous vapor and other gases. The nitrogen in all ordinary cases of combustion plays a part that is entirely neutral, it leaves the furnace in precisely the same condition that it entered, except that its temperature is raised, it undergoes no chemical change, while it serves one very important purpose, viz., that of diluting the oxygen, which in its undiluted condition would cause the combustion to be fierce and uncontrollable. To burn one pound of carbon to carbon dioxide requires 2.67 pounds of oxygen, and when the oxygen is derived from the atmosphere it is accompanied by 8.94 pounds of nitrogen. The specific heat of nitrogen is .244 and the quantity of heat necessary to raise the diluting nitrogen one degree is 8.94 x .244= 2.181 heat units. Adding to this 0.794 the number of H. U. needed to raise one degree the 3.67 pounds of carbon dioxide formed, we obtain 2.975 as the number of H. U. needed to raise the temperature of the products of combustion one degree F. The highest temperature attainable, allowing for no losses by conduction or radiation is clearly $\frac{14500}{2.975} = 4887$ F. By a similar calculation the calorific intensity of hydrogen when burned in air is found to 4934 F. In practice, however, furnace construction very rarely attains a degree of perfection sufficient to secure the complete combustion of the fuel with only the theoretically necessary quantity of air. In furnaces using solid fuel such a degree of perfection is never attained; and to secure reasonably perfect combustion, once and one-half or twice the theoretical quantity of air must be admitted, and in many case where great care is not exercised, the proportion of unutilized air is even much greater than twice the theoretical amount.

When twice the theoretical quantity of air is supplied we have for each pound of carbon: Air 23.22 pounds or 303.39 cubic feet and weight of products of combustion equals 24.22 pounds. For each pound of hydrogen we have Air 76.88 pounds or 908.62 cubic feet and products of combustion weighs 80.56 pounds.

The specific heat of air is 0.2377 and when double the necessary amount is admitted to the furnace, 11.61 pounds of air pass uselessly so far as chemical combination is concerned, through the combustion-chamber. The calorific intensity in the case of carbon will become $\frac{14500}{2.975+11.61 \times .2377} = \frac{14500}{2.975+2.759} = 2530$ F.

A similar calculation in the case of hydrogen gives a calorific intensity of about 3200 degrees F. Even in the best furnaces employing solid fuel a considerable proportion of the combustible

fails to be utilized, owing to incomplete combustion, the fire boxes being generally too restricted to permit of a sufficient commingling of the gases necessary to secure a complete and thorough chemical union of all the elements.

The highest temperature obtainable by combustion is reached by burning hydrogen gas and using pure oxygen in the proper amount as the supporter of combustion, both gases may be highly preheated before they are brought to the point at which they are allowed to burn, the temperature so obtained will easily fuse platinum, which is an extremely difficult metal to fuse.

When the hydrogen-oxygen flame is incompetent, we have recourse to one other source of intense heat, and that is the electric arc, or in it's broader application, the electrical furnace. This affords a temperature, so enormously high that it will not only melt the most refractory metals, but it will convert the liquid metal into vapor, just as water is converted into steam.

Switching Dynamos into Circuit

Frequently two or more machines are connected to a common circuit. Especially is this true in large buildings where the number of lamps required to be fed varies so much that one dynamo may be sufficient for certain hours, but two, three, or more machines may be required at other times. Herein occurs a point which is worthy of attention—the proper method of connecting the machine to the same circuit—the various ways in which this is done depending upon the character of the machine, and of the circuit and the precautions necessary in each case, make this a most important and interesting subject.

Dynamos may be connected together either in parallel (multiple arc) or in series. In case they are set in parallel the plus terminals are connected together, or to the same line, and the minus terminals are connected together or to the other line. The currents (I E amperes) of the machines are thereby added together, but the E M F (volts) are not increased.

The chief condition for the running of dynamos in parallel is that their voltages shall be equal, but their current capacities may be different. For example —a dynamic producing ten amperes may be connected to another generating a hundred amperes, always provided the voltages agree. Parallel working is, therefore, suited to constant potential circuits. A dynamo to be connected in parallel with others, or with a storage battery, must first be brought up to its proper speed, E M F, and other working conditions, otherwise it will short-circuit the system, and probably burn out the armature. Its field magnetism must, therefore, be at full strength, owing to the fact that it generates no E M F with no field magnetism. Hence it is well to find whether the pole pieces are strongly magnetized by testing them with a piece of iron, and to make sure of the proper working of the machine in all other respects before connecting the armature to the circuit.

It is a common accident for the field-circuit to be open at some point, and thus causing some very serious results. In fact a dynamo should not be connected to a circuit in parallel with others until its voltage has been tested and found to be equal to, or slightly (not even one or two per cent.) greater than that of the circuit to which it is to be connected. If the voltage of the dynamo is less than that of the circuit, the current will flow back into the dynamo and cause it to be run as a motor. The direction of rotation is the same, however, if it is shunt wound, and no great harm results from a slight difference of patential. But a compound wound machine requires very careful handling, indeed.

A New Internal Combustion Engine

Much interest has of late been aroused by the exhibition abroad of numerous makes of high power engines of the internal combustion type, and by subsequent reports, concerning their probable manufacture in America. Although much more attention has been devoted to this type of prime mover abroad, and its development has therefore been more marked, it is noteworthy that American manufactures have in the meantime been conducting operations along this line, with the result that internal combustion engines of American design and American manufacture, in sizes as high as several thousand horse-power are in evidence for service as exacting and severe as that for which the high grade steam engine is now almost universally employed.

In the domestic field few makers have ventured above 250-H. P., and until recently, none above 500-H. P.—with one exception—The Westinghouse Machine Company, whose three-cylinder, vertical single-acting engine is well known. This Company has, however, been for some time engaged in developing the double acting type, and it is now prepared to build this engine, for powers ranging as high as 3000-H. P. As this type of engine possesses features somewhat novel to those accustomed to the usual reciprocating engine design, a brief description may be of interest.

Figure 1, shows a perspective view of a single crank engine of the new type,

It is quite apparent from the accompanying view that the general design of the engine resembles to a noticeable extent that of a modern high speed tandem compound steam engine in the arrangement of cylinders, frames, bedplates, bearings, flywheel and generator. This resemblance is further carried out in the matter of crank effort. Each and every revolution is accompanied by two impulses, one occurring at each successive in-stroke and out-stroke. The engine operates therefore upon the four stroke cycle, involving distinct periods of admission, compression, explosion, expansion and exhaust; a cycle yielding the highest practical as well as theoratical efficiency and economy of fuel.

The employment of the four-stroke cycle involves a feature of the greatest importance, that of positive scavenging. A comparison of the thermal values of natural and blast furnace gas emphasizes the necessity of pure working mixture. The former yields approximately 1,000 B. T. U. per cubic foot, and the latter but 100. Although the comparative weakness of the latter is partially due to the absence of the highly calorific CH, or marsh gas, it is mainly attributable to the presence of N Co, and N, both inert gases resulting from previous combustion. In all engines employing the two-stroke cycle, scavenging must be accomplished either by a special piston movement or by a blast of air from an auxiliary pump, directed in such a manner as to force out the remaining burned gases, thus clearing the way, so to speak, for the incoming pure mixture. This latter method, the most practical one, can evidently result only in a dilution of the incoming mixture, and variations in the calorific value of the explosive mixture, which for gas of given constituency, should be maintained constant. These points have received careful attention in all Westinghouse designs. The engine under description scavenges thoroughly and completely upon the return stroke of the piston, which then draw in their charge of explosive mixture, undiluted either by products of combustion or by scavenging air

In direct distinction from the use of an explosive mixture varying in richness according to the load, the Westinghouse design employes a mixture of unvarying quality, which is initially proportioned according to the nature of the gas used, but which remains constant under all conditions of load. As the load upon the engine increases or decreases, a corresponding greater or lesser quantity of mixture is admitted to the cylinders, thus utilizing at all times an explosive mixture of *maximum* strength, resulting in higher thermal efficiency and economy of fuel. That this method is productive of the best results in engines of high power is apparent from the fact that reputable European builders, such as the Deutz Cockerill and Nurnberg Companies are abandoning the variable for the constant mixture method of governing.

At the ends of each cylinder occur horizontal side ports, resembling straight steam ports, which communicate with removable combustion chambers. The cylinders are closed by water jacketed heads, those located between the wo cylinders being split diametrically for facilitating inspection of the interior, and the two halves are united with a ground fit, no packing being found necessary. This feature obviates the necessity of completely dismantling the engine for inspection.

The location of valves and combustion chambers in the new design is especially fortunate, and the contrast between the simplicity of this arrangement, and the formidable complexity of numerous European types is striking. The arrangement shown in the accompanying illustrations accomplishes the same purpose at farless cost and with less complexity. The com-

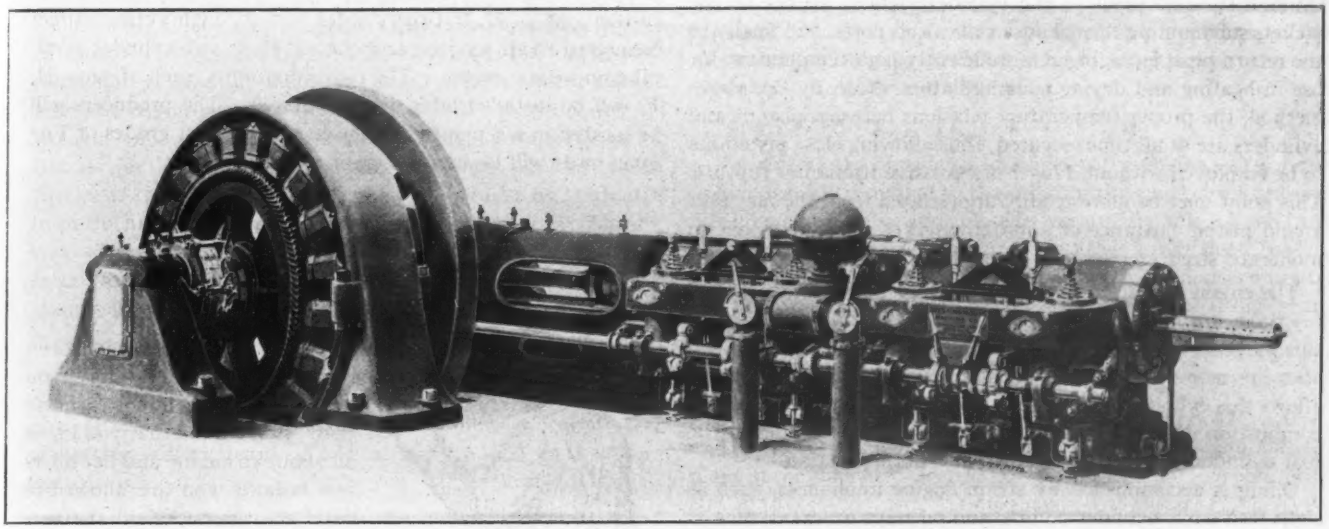


Fig. 1.

The construction of the engine under description is in many respects unique in that it departs materially from the accepted European design, and embodies many established features of modern steam engine practice, which have been so instrumental in bringing about the success of the well known Westinghouse vertical single acting type. From crank to cylinders, the construction is that of a horizintal steam engine, suitably strengthened in proportion to the increased maximum pressure resulting from the rapid combustion of the highly compressed gases. The design of cylinders, pistons, and valves, of course departs materially from steam engine practice. The cylinders are double walled, with the outer wall split peripherally, to permit independent expansion and contraction withoutplacing the cylinder casting under stress. The two cylinders are united at the top by heavy tie rods, engaging peripheral bosses, and at the bottom by a stout cast iron distance piece. The rear section of the bed plate, which supports the two cylinders, is cored hollow, with a central dividing wall, and serves as a reservoir for incoming and outgoing circulating water. All connections are piped directly to these reservoirs, thus avoiding a large amount of piping about the engine. Through the bedplate extend the four vertical exhaust pipes, which connect immediately below with an exhaust main. The exhaust passages leading from the valve chambers are cast integral with the cylinders, upon their under sides, and are water cooled.

bustion chambers are independent castings, with plain machined faces, circular valveliner seats, and cored cut passages for circulating water. Both admissi on and exhaust valves, which are of the standard poppet type, operate vertically and with opposite throw. They open by cam movement, and are held to their seats by spring pressure. The central space, closed by the admission valve above, and the exhaust valve below, communicates directly with the cylinder port before mentioned; the exhaust space with the exhaust passages on the under sides of the cylinders; the admission space with the supply pipe. This supply pipe is a rectangular cast iron main extending along the entire front and provided with openings opposite each admission valve. It receives its supply from the governor chamber, located midway between the two ends, this in turn communicating with a mixing chamber, supplied on the one hand with gas and on the other with air through suitable valves. These two valves are shown in Figure 1, and are provided with graduated indices, so that the exact proportion of gas and air may at all times be visible, and under the control of the attendant. Another feature of the greatest importance is found in the provision for interchangeable parts. Each valve, together with its spindle and seating spring, is independently mounted, and by simply removing the bolts from the bonnet, the entire valve, seat and liner, may be drawn out for inspection or replacement by a space. Similarly the igniters, which are of the "make

and break" electrical contact type, employed in all Westinghouseengines, are mounted in a removable plug extending into the combustion chamber, through the side walls.

The valve gear is of the standard cam and roller pattern, also employed in the Westinghouse vertical engines, and is driven by a helical gear, engaging a similar split gear bolted around the main shaft.

The method of circulating cooling water through the pistons is unique. This water enters a cavity of the cross-head by means of a flexible pipe connection provided with special swinging joints. It then flows through the hollow piston rod to the front and rear pistons, through which it circulates, finally emerging through a bronze tail rod extending through the rear head, there emptying into a cast iron jacket communicating with the hot water return pipe. Similarly, cold water is conducted through suitable pipes to the cylinder jackets, thence to the jackets surrounding the exhaust valves and ports, and finally to the return pipe, emerging at a sufficiently high temperature for use in heating and drying coils, radiators, etc. By the above method, the proper temperature relations between pistons and cylinders are at all times secured, thus allowing close piston fits to be employed without danger of excessive friction or rupture. This point may be more readily appreciated from the fact that a cold piston clearance of approximately 1-16 is necessary in moderate sized engines not fitted with water cooled pistons

The engine is started by compressed air pumped into a steel reservoir during a previous run before shutting down. For this purpose, a special disengaging gear is provided, which isolates the rear cylinder, and, on admitting the compressed air, allows this cylinder to operate as an air motor until the regular combustion cycle is taken up in the forward cylinder. The rear cylinder may then be thrown into normal action.

Oiling is accomplished by steam engine appliances, such as sight feed cups, cylinder pumps, and oil rings for crank pins.

The engine is governed by a sensitive fly-ball governor of the standard design, protected by a circular housing. It operates a vertical piston valve supplying a fuel mixture of constant quality, but in quantities proportionate to the load.

The single crank engine is at present manufactured in sizes ranging from 250 to 750 H. P., and the double crank from 750 to 1500 H. P. In the latter, cranks are placed at 90° angularity, giving four impulses per revolution, and a crank effort corresponding to that of a cross compound double acting steam engine.

It is of interest to note that several installations of this type of engine are in progress. The first to be put into operation will be at the works of the Consolidated Industries Company, Batavia, N. Y., employing 250 H. P. single crank, double acting engines, direct connected to Westinghouse alternating current generators, operating in parrallel upon a general light and power distributing system. A special coke and gas process, known as the Lowe, will be employed, yielding three products, metallurgical coke, coal and water gas, the former to be retailed and the latter used for power purposes.

A second installation will be at the works of the Atlantic Refining Co., Phila. The engines are double crank, double acting, of 500 H. P. each , and are direct connected to Westinghouse 350 K. W. three-phase generators, arranged for parallel operation. The engines will operate upon rich oil gas of approximately 1,400—B. T. U. per cubic foot, a by-product of the refining processes.

A further and more recent instance of the confidence placed in the gas power a paratus is that of the Potosina Electric Company, of San Luis, Potosi, Mexico, a town of 7,000 inhabitants, situated at an elevation of 6,000 feet above sea level, about 275 miles north-west of Mexico City. The town was formerly sup plied with electric light and power from a D. C. steam-driven plant, which passed into the control of the present company, and has been converted into a gas central station.

The plant has been laid out for five main units, an exciter unit and a compressor, aggregating 1,225—H. P., and will employ the Loomis-Pottibone process for generating a power gas of approximately 120 B. T. U. per cubic foot calorific value. At the present time, but five engines will be installed, comprising three 150 H. P. single crank double acting machines, direct connected to Westinghouse polyphase generators, operating in parrallel upon the general 2,200 volt threephase distributing system; one 50 H. P. two-cylinder verical single acting, direct connected to an exciter; and one 14 H. P. two-cylinder vertical compressor engine. The remaining units, each of 340—H. P. will be installed later, when required. The producers will be located in a separate gas house, and the best grades of Virginia coals will be used for gasification purposes.

The Noon Hour at Power's Mill

BY A. EDWARD RHODES.

"Now, see here; don't you try to tell us men what have been runnin' engines long afore you was born any such fool yarns as that. Don't think that you know all about an engine and her bilers just because you are allowed to wipe the grease offen' the new engine. If I'd a knowed you'd a got so stuck up, I'd a never spoke up for you to Mr. P. when he said he was agoin' to give you the job of runnin' the new engine. As I told you afore there are many other just as good men as you around this mill, what are as good a engineer as you ever will be, with all your edication and book-learnin', if I do say it myself."

The above was brought forth from old Dick, as he was familiarily called by his fellow engineers, at noon the other day, by a remark of the kid's regarding what he thought was the reason one set of piston rings seemed to wear better, last longer, and require less apparent care than another set of the same kind, on another engine of the same size, and, as far as could be seen, exactly the same conditions.

There were present in old Dick's engine room, this particular noon hour of which I am writing, Joe and Jim, two firemen, employed by Mr. P., several engineers and firemen from the mills close by, attracted there like myself each noon hour by the good fellowship prevailing, to listen to and sometimes take part in the arguments between old Dick and his assistant, Charlie, better known to us as kid or the boy. Between these two there

appeared (on the surface) to be a large and continual enlarging antagonism, each trying to show the other up. Yet, we all know that there are no two engineers working together in our city that are as good friends at heart as these two men, each respecting the other's particular knowledge of their profession, and constantly striving to get all that he can from the other. Their methods for so doing are characteristic of the two men, Charlie assuming a very learned and stuck up manner, which is sure to provoke Dick's wrath, and bring forth, generally, just what the kid wants to know. On the other hand, Dick assumes, in a gruff, surly way, that the only way a man can know anything about an engine is to grow up with her, and run three or four of them so long as they will hold together, and "jist a little longer." It's no use studdyin' anything but how to squirt oil on a hot box, and how to set a key, etc., etc.

Dick and Charlie represent the two extremes of education as usually found in an engine room. Dick has learned the practical side of the business by hard knocks in the fire and engine-room, and as he says, "there ain't a bolt, rivet, er patch about a biler and engine-room, as I don't know better than I do my old woman, and we've been married now nigh unto forty years. But as for book-learnin' that's good enough for sich smart Alecks as the kid here. He thinks that because he graduated from the high school, and then took a course in the correspondence school that he knows it all. Say, kid, show us now how smart you are. Mr. P. was in here this mornin' a consultin' me about how many heater pipes to put in that room over the office; bet he don't know."

This demand upon Charlie was made, as we all saw, even if Dick did not think we did, so that Dick could give Mr. Powers an estimate of the number of square feet of heating surface required to heat a given number of square feet of air.

Charlie's reply, as near as I could remember it, when I got my engine started for the afternoon run (for I wrote it down, as I often do things that might be of use to me sometimes in the future, and I have found it a good plan, too): "I was looking up this very subject last night, and I find that positive rules for steam heating, which will be correct for all parts of the country, cannot be given, as the conditions are so varied, depending upon locality, climate, and heat required, and, also, on the conditions found to exist in any particular building. When a building has large glass surfaces, or is composed of iron, etc., the air within is cooled more rapidly than in ordinary buildings, with average windows, and other average conditions. Buildings of this kind will require an extra amount of heating surfaces, as the air is cooled by coming in contact with the surfaces of the windows and walk. The steam engineer has nothing more than averages to depend upon for his guidance. In case of small corner rooms, like the room you spoke about, with low pressure steam, in climates like Pennsylvania or Delaware, one square foot of average radiator surface to each 50 cubic feet of air space, is generally considered ample. With large rooms, 1 to 60 is often enough, and in halls and stores, 1 to 100 is usually considered sufficient, while in many churches, 1 to 150 is all that is needed. Now, allowing that 50 cubic feet of air space can be heated by one square foot of heating surface, all that we need do, is to find the number of cubic feet in the room. Yesterday, I measured the room, and found that it was ten feet wide, 12 feet long, and 8 feet high. Its cubic contents are 10x12x8—960 cubic feet. To find the number of square feet of heating surface I divide 960 by 50—19½ square feet of heating surface."

"Humph, it took a long time to tell it, but he is right, as I was a sayin' to Mr. P. this mornin' only, that I would put in 20 feet of heater. You keep at it Charlie, and some day your book-learnin' will get you a better job than you now have."

Water in Elevators

Loss of power by friction is caused bythe lack of lubricating properties of the water used in hydraulic elevators. Soft water makes less friction than hard water from service pipes. The condensed water taken into the elevator system will cause corrosion and wear of the cylinders. Filtered water is good; so is soapy water, which will double the life of the packing, reduce the loss of friction, prevent chattering of pistons, and make the elevators run much smoother. Soap powder added to the water in elevator tanks in the proportion of one pound of powder per week per 400 gallons will be found to more than pay the cost by saving of power and repairs.

To reverse the turning of a single valve engine:—Turn the engine until it is on one or the other of the exact dead centers. Then mark the valve stem close to the stuffing box. Then turn the engine over until it reaches the other exact dead center, unfasten the eccentric and turn again until the mark comes to the first position. Refasten the eccentric. By using great accuracy the valve and lead will not be changed.

The Philadelphia Tapestry Mills, manufacturers of tapestries and light carpeting, two years ago decided to operate their plant throughout by electric power and for that purpose purchased, a 150-kilowatt, Westinghouse, two-phase, engine-type alternator, together with from 12 to 15 type C induction motors. This plant has given such satisfaction that they have now decided to duplicate it and have recently contracted with the Westinghouse Company for another alternator of the same size. The type C induction motors have been found especially valuable in work of this kind, since they are not affected by dust, lint, or dirt of any sort, and having no commutator nor brushes, do not give rise to danger from fire.

Mechanical Draft Plant for St. Louis Fair Use

Mechanical Draft Plant for St. Louis Fair Use.

The mechanical draft feature of the Union Electric Light and Power Company's plant, which will be used for lighting the World's Fair grounds at St. Louis, will be an installation of unusual interest to engineers. The plant is to be equipped with both forced and induced draft apparatus, which is unusual. A mechanical draft plant usually is either of the forced or induced draft type, but in this case both will be used. There will be 26 boilers of 700 horse-power each, and will be equipped with automatic stockers. Fans will be used for the forced draft, and the boilers will also be operated under induced draft. The forced draft fans will be four in number, of the full housing type, size 160 inches. They will be driven by 10 x 10 vertical engines, direct attached. The induced draft fans will be two in number, of a size in keeping with the exposition, the wheel diameters being larger than is usually met wth in mechanical draft engineering. Each of these induced draft fans will be of the full housing type, size 230 inches, and will be driven by 9 x 10 double cylinder double acting, upright engines, this type being selected to secure the maxmum power in limited space.

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The Elementary Causes of Boiler Explosions

How many engineers or mill owners realize the great risk they daily assume when forcing boilers? Yet, it is becoming a more frequent practice all the time. It may be said with a degree of certainty, that this practice of forcing boilers is prolific of more disastrous explosions than any other cause.

Pulsation in steam-boilers, though not discernible to the eye, as in animated nature, goes on intermittently in some boilers whenever they are in use. It is induced by weakness and want of capacity in the boiler to supply the necessary quantity of steam, and sometimes is caused by the boiler being badly designed, thereby admitting of a great disproportion between the heating-surface and steam-room. Boilers are frequently found in factories that were originally not more than of sufficient capacity to furnish the necessary quantity of steam, but, as business increased, it became necessary to increase the pressure and also, the speed of the engine; or, perhaps to replace it with a larger one, which has to be supplied with steam from the same boiler. The result is, each time the valve opens to admit steam to the cylinder, about one-third of the whole quantity in the boiler is admitted, thus lowering the pressure; the next instant, under the influence of hard firing, or, perhaps, a forced draught, the steam is brought to the former pressure, and so on; this lessening and increasing the pressure continues while the engine is in motion, which has an effect on the boiler similar to the breathing of an animal.

The strains induced by this pulsation are transmitted to the weakest places, viz., the line of the rivet holes, and that marked by the tool in the process of calking; the result is, the plate is broken in two. The manner in which the break takes place may be illustrated by filing a small nick, or drilling a small hole, in a piece of hoop or band-iron, and then bending back and forth, when it will be discovered that the material will break just at that point, however slight the nick or small the hole may be. Pulsation is frequently very severe in the boilers of tug-boats when commencing to start a heavy tow, and also in locomotives when starting long trains. Some frightful explosions of the boilers of tug-boats and locomotives have occurred under such circumstances. Pulsation, if permitted to continue, is sure to effect the destruction of the boiler. It is always made manifest by the vibrations of the pointers on steam gauges, or an unsteadiness in the mercury column. It may be remedied, to a certain extent, by adding a larger steam dome, but this has a tendency to weaken the boiler and render it more unsafe. The only sure preventive of such a silent and destructive agent is to have the boiler of sufficient capacity in the first place.

The Effects of High Speed

There appears to be a doubt in the minds of a great many as to just what is meant by the term "high-speed" as applied to the steam engine. Some apply it to the piston travel, while others understand that it refers to the number of revolutions per minute of the engine. The latter meaning is by far the more widely accepted, and it will be found that in the greater majority of instances where the term is employed, it is taken to mean a large number of revolutions per minute. This is further evidenced by the fact that Corliss engines are classed as low-speed engines, even although the piston speed may be as high as 1,000 feet per minute.

It is exceedingly difficult to name the rotative speed which shall be the minimum or lower limit of the high-speed class of engine. But it is safe to say that engines making 200 revolutions per minute, or over, are high-speed engines.

The high-speed engine has several distinct advantages, and the first of these is that the engine may be made smaller and lighter for a given power than a low-speed engine. The horse power of a steam engine is represented by $\frac{\text{PLAN}}{33000}$. Now, if the number of revolutions is largely increased, the term N will likewise be increased, since N represents twice the number of revolutions per minute, or the number of strokes per minute of the engine.

It must be evident, therefore, that if N is increased, the product of the other factors in the numerator may be

decreased, and yet have the same horse power. In the high-speed engine this is done by decreasing L A in the same ratio that N is increased. The result of this procedure is that the length and the area of the cylinder are made less. In other words, the cylinder is made considerably smaller.

But the travel of the cross-head and the diameter of the crank circle are each equal to the length of the stroke. Hence, the increase in the number of revolutions has not only lessened the cylinder dimensions, but it has given a shorter cross-head travel and less throw of crank. Consequently the frame or bed of the engine may be made considerably shorter. And this decrease in general dimensions means less material, less weight, less space occupied, and less cost.

The cylinder takes steam twice during each revolution of the engine. Therefore, by making N larger, the cylinder volume is filled more frequently. Now, it is well known that there is an enormous amount of condensation of steam in the ordinary steam engine during the period of admission. Consequently, by increasing the number of admissions per minute, it would be natural to conclude that a greater loss by cylinder condensation would naturally result.

Contrary to any such opinion, however, the very opposite is true. For the steam consumption per horse-power per hour of the high-speed engine is less than that of the low-speed. The reason for this is not difficult to explain. Condensation is caused by the loss of heat from the steam to the cylinder walls. The amount of this condensation depends upon the difference in temperature between the entering steam and the cylinder walls; upon the amount of surface of metal exposed to the steam; upon the rapidity of conduction of heat of the metal; and upon the length of time during which the steam touches the walls.

Now, by increasing the number of revolutions, the time during which the steam is in contact with the cylinder is much decreased. Consequently, there will not be so much heat lost from the steam to the walls. The walls, also, will not be able to conduct this heat so quickly to the outside air, and the result is that the temperature of the cylinder will fluctuate through a smaller range. Instead of varying from the temperature of the steam at admission to the temperature at exhaust, as would be more nearly the case in a low-speed engine, the temperature of the cylinder walls remains more nearly constant, and approaches more closely the initial temperature of the steam. So that all in all, the high-speed engine will show a better steam economy than a low-speed engine of the same general type.

The high-speed engine has the advantage of a quick and close speed regulation also. On account of the large number of revolutions per minute, any sudden fluctuation of the resistance will be quickly felt and compensated for by the governing mechanism, since but a very short time elapses between cut-off on one stroke and cut-off on the succeeding stroke. On a low-speed engine, if a large decrease in resistance should occur, on the forward stroke, just after cut-off, the governor could not act until the following stroke, during which interval the speed would increase, unless a heavy fly wheel were used to counteract any such tendency. The high-speed engine does away with the use of a massive fly wheel.

There are disadvantages, also, in the use of a high rotative speed for engines. Since the rubbing surfaces are smaller, and move more rapidly, and are brought into contact far more frequently, the wear is increased. To obviate this, efficient lubrication must be observed, and the problem of the lubrication of high-speed engines is a hard one. The heating of bearings and crank-pins, and the wear of the valves and valve- seats require that the parts be accurately fitted and that facilities for close adjustment be provided.

Wire-drawing of the steam is another trouble experienced in high-speed engine work. With the ordinary slide valve, the port opening near cut-off becomes small when the piston is moving at or near it's maximum velocity. The result is that the steam is throttled or wire-drawn. This means practically an imperfect expansion of the steam.

Finally, there is the disadvantage of excessive vibration. Owing to the exceedingly rapid motion of the reciprocating parts, and the number of times per minute they must, change their direction of motion, oscillating or vibratory tendencies are created which must be overcome by securing the engine firmly to a good solid foundation.

Storage Battery Manufacture Now Open to All

The electrical publications are rather jubilant over the fact that the fundamental American storage battery patent, known as the "Brush" patent, expired on March 3. This patent was sustained in the United States Courts, after repeated attacks, and its natural expiration will make available principles of storage battery manufacture to secure which millions of dollars were expended in fruitless litigation, and which have rendered the storage battery business a practical monopoly. All the batteries heretofore sold in any quantities in this country have been of the Brush type. It is even contended that it was doubtful whether the Edison cell, unique as it is, could have been marketed without infringing Brush's basic patents. Whether the throwing open to the electrical manufacturers of this country of these patents will infuse new life into the business and promote a rapid growth in the application of storage batteries is a mooted question even among those best informed. In any event, the field is now an open one.

Electricity on the elevated roads in New York has thrown out of service 325 small locomotives which cost over $2,000,000. They will be sold cheap and bought by lumbermen and for switching about factory yards, etc.

QUESTIONS and ANSWERS

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

Editor THE PRACTICAL ENGINEER:

In your answer to John J. Lynn, in regard to how to estimate the horse-power of the size boiler as specified, you say: "The simplest rule and the quickest way to find the heating surface of a boiler, is to multiply the number of quare feet of grate surface by 45. Thus we have in your case 3x5x45=56.25, the horse-power of your boiler".

I understand, according to this, that the heating surface is 675 square feet, and 675 ÷ by 12 feet(the rating for a simple Corliss engine). Where do you obtain the 45, with which you multiply the grate surface? Is this a constant number, and can the 45 be used in the determination of horse-power in any boiler? I ask these quesions for information, and trust that you will answer through your valuable columns.

FRANK C. B. SPEACE.

[Your understanding of the answer is correct. The figures 45 constitute a constant number, and can be applied in the same manner in obtaining the horse-power of any size boiler, of the horizontal tubular type.—EDITOR.]

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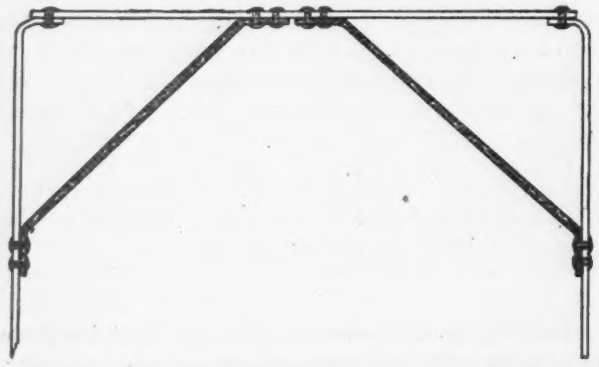
Editor THE PRACTICAL ENGINEER:

Please answer the following questions in the "Question and Answer" column. They will probably seem very simple to you, but I am only a student of Mechanical Engineering, and there are many things that I cannot understand.

1. How is the tensile strength of boiler found? 2. What is a stay bolt? 3. Which is hotter coming out of the same boiler, water or steam?

HERBERT BLANDING.

[The tensile strength of boilers is determined by taking a piece of metal from the plate, at its thinnest part and subjecting



it to strain until it parts and marking the result. Of course, after a boiler is made up, this is impracticable, but there is a set standard allowed for iron or steel of different thickness; by drilling a hole in the boiler shell and determining this point, it is easy to find the tensile strength by consulting your table.

[A stay bolt is simply what its name designates—a stay to prevent the bulging of boiler heads. A glance at the accompanying engraving will explain its use to you.]

[When heat is applied to a liquid, its temperature, as indicated by a thermometer suspended in it, rises steadily, and the product of its rise in temperature, multiplied by its specific heat, will equal the number of heat units applied to it. At last it reaches a point where vapor (steam) is given off, and, although heat is still being applied, the temperature no longer rises, but remains constant till all of the liquid has been changed into vapor. The heat which goes to change the state of the substance from that of a liquid, to that of a gas, and which does not show on the thermometer, is called latent heat. After all the liquid changes to vapor, any further addition of heat raises the temperature of the vapor. For instance, we find in consulting a steam table that there is, at 100 pounds pressure, 1181.9 heat units per pound of water, in the boiler, and of this we find the water only contains 297.9 units, while the balance 884.0, is latent in the steam; hence the steam is three times hotter than the water.—EDITOR.]

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Editor THE PRACTICAL ENGINEER:

I am in charge of a battery of boilers joined together with a steam dome 10 feet long by 2½ feet in diameter. The dome is made up of ¼ inch steel and is exposed to the atmosphere; in addition to this the boiler house has number of cracks in the walls through which the wind blows.

On another boiler, I have a few leaks, probably amounting to as much as would escape through a quarter inch pipe.

Which of the two is the greater loss?

T. C. WRIGHT,

Belleville, Ill.

[The loss in steam through a quarter inch leak at one hundred pound pressure, amounts to about 5-16th of a pounds of steam per minute, or 456 pounds per 24 hours.

Now, under average conditions, one pound of coal will evaporate about 6 pounds of water at 212 degrees, consequently, you you are losing through the leak, approximately, 76 pound of coal per 24 hours.

In refernce to the amount of heat lost through radiation from the uncovered connection, we should say that you lose over four times the above amount. For instance: It requires 1015 heat units to convert one pound of water into steam from feed water at 200 degrees. Now, there is a loss of about 20 heat units per minute, to the square feet of exposed surface band, you have 88 square feet exposed, hence you lose in 24 hours (at 100 pound pressure) 2,534,400 heat units. Presuming that one pound of coal generates 11,000 heat units, of which 65 per cent. is absorbed by the water in the boiler during the steam-making process, and we find that you are losing 354 pounds of coal lost per 24 hours' run.—EDITOR]

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Editor THE PRACTICAL ENGINEER:

Will you kindly give the important points of how to proceed to line an engine to line shafts.

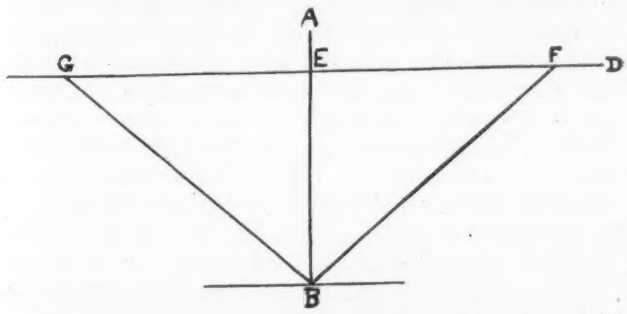
P. W. HOWE.

We will suppose the lower shaft not yet in place, but to be represented by a line tightly drawn. From two points, as far

apart as practicable, drop plumb lines nearly, but not quite, touching this line. Then by these strain another line parallel with the first, and at the same level as the centre line of the engine, and at right angles with this stretch another representing this center line, and extend both each way to permanent walls on which their terminations, when finally located, should be carefully marked, so they can at any time be reset. The problem is to get the latter line exactly at right angles with the former. Everything depends upon the accuracy with which this right angle is determined. It is done by the method of right angled triangles. There are two ways of applying this method. In the first one end of a measuring line is attached to some point of line number one, and its other end is taken successively to points on line number two, on opposite sides of the intersection, as illustrated in the following figure, in which A. B. is a portion of number one, and C. D. of line number two, the direction of which is to be determined.

B F and B G are the same measuring line fixed at B, and applied to the line C D successively at the points F and G. The distances B F and B G being therefore the same, when E F is equal to E G, the lines A B and C D are at right angles with each other. In the second, application is made of the law that the square of the hypothenuse of a right triangle is equal to the sum of the squares of the other two sides. Thus 3^2 plus 4^2 equals 5^2 So if the above figure E B equals 4, E F equals 3 and B F equals 5, the angle at E is a right angle.

Any unit of measure may be used, a foot is generally the convenient one; so any multiple of these numbers may be taken; as, for example, 6, 8, and 10. Respecting the comparative advantages of these two ways the situation will often determine which is to be preferred. In the former, the diagonal being



the same line, fixed at B, and brought successively to the points F and G, its length is immaterial, though the only point to be determined is the equality of the lines E F and E G, which may be compared with each other by marks on a rod. In the latter, the proportionate lengths 3, 4 and 5, or their multiples, must be exactly measured. It is better adapted to where floors are laid and the measurements can be transferred by trammels. The result should be verified by repeating the operation on the opposite side of the intersection at E, and when so verified we have, in fact, the first process, without the additional and unnecessary trouble of determining the relative lengths of the lines. Care should be taken when a measuring line is used to avoid errors from its elasticity. On this account a rod is often employed. Points on the lines are best marked by tying on a white thread.

In case the engine is to be lined in direct connection with the shaft we will suppose that the engine bed and the bearings for the shaft are already approximately in position. They are eveled by a parallel straight edge and a spirit level. To line them horizontally a line must be run through the whole series of bearings and continued to a permanent wall at each end, and its terminiating ends, when determined, carefully marked, as already directed. A piece of wood is tightly set in each end of each bearing and the surfaces of these are painted white or chalked. Then the middle of each piece being found by the compasses two fine lines are drawn across it, equally distant from the middle, and having between them a space a little wider than the thickness of the line. This being then strained, nearly touching those blocks, or, if long, having its sag supported by them, the two marks on each must be seen, one on each side of the line, with the line of white between.

* * *

Editor THE PRACTICAL ENGINEER

Please explain in the PRACTICAL ENGINEER, how to calculate the consumption of steam (water) from an indicator diagram?

A READER.

If the number of cubic feet occupied by the steam in an engine cylinder, and the pressure it exerts against the piston at any point of the stroke be known, the number of pounds which the steam weighs may be computed.

The weight of the steam at any point, less the weight remaining in the cylinder at compression, is the weight accounted for by the indicator.

The weight accounted for on one stroke, multiplied by the number of strokes per hour, and divided by the indicated horse-power, is the amount of steam accounted for per indicated horse-power per hour.

This computation requires a knowledge of the volume of the clearance space in the cylinder; that is, the cylindrical space between the cylinder head and the piston, when the piston is at the end of its stroke, and also includes the volume of the steam ports and passages which conducts the steam from the admission valve to the cylinder, and also from the cylinder to the exhaust valve.

The water consumption of an engine is the measure of its economy, but the exact amount is not determinable from the diagram, because that gives the pressure of steam only.

Of the water that has been carried over with the steam, or of the steam that has been condensed by coming in contact with the comparatively cold surfaces of the cylinder, the diagram gives no record.

We know however, that the amount of steam accounted for by the indicator has at least passed through the cylinder; and in fact, we know that sometimes a much larger amount has been used.

One method of ascertaining the amount accounted for by an indicator is to calculate the piston displacement, plus the clearance space for a given time, in cubic feet, up to a certain point in the stroke before the exhaust opens, and multiply this volume by the weight of a cubic foot of steam of the absolute pressure at this point.

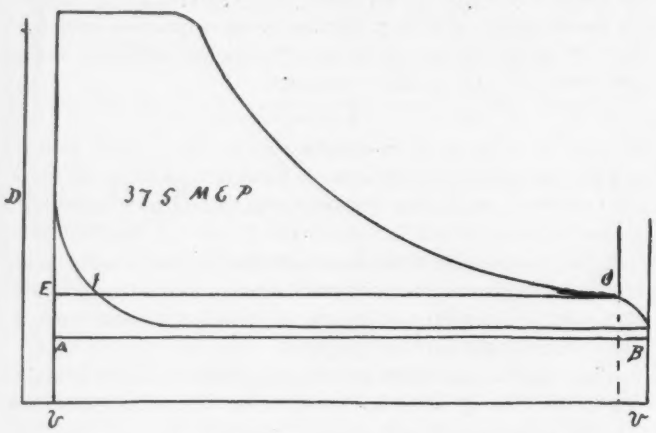
This method is described in the diagram Fig. 1 and is as follows:—Draw the vacuum line V.V., and the clearance line D. and select some point on the expansion curve, as at C. where it is known that both the steam and exhaust valve are closed and wherever it is possible, have this point C ata distance from the end of the diagram equal to the clearance distance D.

Where this can be done, then the volume to point C, including clearance, will just equal the piston displacement which is the area of the piston multiplied by the length of stroke.

Where this cannot be done, then find volume to point C, including clearance, which if multiplied by the weight of a cubic foot of steam of the absolute pressure at the point selected will give the weight of the steam contained in the cylinder at such point.

The volume at point C may be found as follows:

Assume the cylinder of an engine to be 12 inches in diameter, (113.09 square inches in area) with a stroke of piston of 30



inches running 90 revolutions per minute; the area of piston rod being 6.18 inches; the clearance being five per cent and the scale of the spring 40.

From the area of the cylinder, deduct one-half the area of the piston rod ($\frac{6.18}{2}$=3.09 inches) hence: 113.09-3.09=110 square inches as the mean area of the piston.

The total piston displacement per stroke therefore will be, the mean area of piston in inches, multiplied by length of stroke, also in inches 110x30=3300 cubic inches per single stroke of the engine.

The displacement to the selected point C, may then be ascertained, by multiplying the total displacement, (3300 cubic inches) by the distance that point C, is from the initial end of the diagram, or from line E, and dividing this product by the total length of the diagram, or line A, B, for example: The length of the line C, E, is 3.56 inches, and the length of A, B, is 3.75 inches, therefore $\frac{3300\times3.56}{3.75}$=3132.8 cubic inches.

To this must be added five per cent for clearance, or 3300x.05 =165. then 3132.8×165=3297.8 cubic inches occupied by steam at point C. The engine running 90 revolutions per minute consequently makes 90x2x60=10800 single strokes per hour; therefore the displacement per hour is $\frac{3297.8\times10800}{1728}$=20611 cubic feet.

The absolute pressure at point C, is 26 pounds and the weight of a cubic foot of steam at this pressure is .065, hence the weight of steam at this point per hour is 20611x.065=1339.71 pounds.

From this amount, however, the steam saved by compression caused by the closing of the exhaust valve before the end of the stroke, must be deducted; the remainder being the actual consumption of steam as accounted for by the indicator.

The process by which to ascertain the amount of this deduction is as follows:

From the selected point C, draw a line parallel with the vacuum line to E, intersecting the compression curve at point F; multiply the accounted consumption by the distance from C to F, and divide this by the distance from C. to E.

The length of the line from C to F is 3.32 inches, and that of the line from C to E is 3.56 inches, hence, $\frac{1339.71\times3.32}{3.56}$ = 1249.39 pounds of steam exhausted per hour, corrected for both clearance and compression. The Mean Effective Pressure of the above diagram (measured by Planimeter) being 37.5 pounds per square inch, the Horse-power is $\frac{110\times37.5\times450}{33000}$ = 56.25, hence the steam accounted for per horse-power per hour will be $\frac{1249.39}{56.25}$=22.21 pounds.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

Mysterious Boiler Explosions

Editor THE PRACTICAL ENGINEER:

I have noticed during the past few months that there has been reported more than the usual quota of boiler explosions, and, I might say, with more than the usual loss of life. One of the strongest features noticeable in the reports of these disasters is the element of mystery, which always surround them. Now, it is this so-called mystery, that I am going to discuss, and in doing so, perchance, we may discover why these explosions are so often mysterious.

First, we come to the often quoted theory, "Our engineer made periodical inspections of our boiler, and at the last inspection everything was in excellent condition." Now, the question arises, is the engineer always competent to inspect his boiler from an unpredjudiced stand-point? Isn't it true that if he finds his boiler in too bad a condition and reports the same, that he is more often than not censured for letting it get in such shape? Then, again, if he have the temerity to brave the "Boss's" displeasure and reports the fact that the boiler needs replacing with a new one, the old one needs retubing, or things of like nature, can he depend upon getting what he asks for? No; the "Boss" usually thinks that he knows what the engineer needs in the plant better than the engineer does. Thus things are let go on and on until there occurs an explosion; usually, the engineer is killed and there is no one left to dispute the "mysterious explosion" theory and that is the end of the matter.

Secondly, we come to the cases, not mysterious, where insurance inspectors have ordered repairs to be made which, not having been done, has caused a cancellation of the policy. The boiler is still continued in service untill, sooner or later, comes the inevitable explosion and, with the usual loss of life. Here, again, we come to a case of an incompetent engineer for, I think that where an insurance company will not risk their money, a competent engineer will refuse to risk his life.

I am sorry to say, however, that there are men who think so little of their lives, and of the lives of their fellow men, that they are very ready to take such positions. I have in mind a particular instance of this kind, the place in question, being a cotton Gin, the owner of which has little or no knowledge of things mechanical. He has, employed to run the engine and boiler in connection with the Gin, a fire-puncher who don't even know how to operate his injector, hence if his pump fails him there will have to be a new Gin built where the old one now stands. I might add that the explosion may occur before the pump fails, for the man has no idea of the requirements of a boiler, he will fill it up pretty well with water and then go take a smoke, until he thinks the water is low. In one case, I know, that he had to be awakened from a little nap to do the work by

some of the hands who noticed that there was no water showing in the glass.

In yet another case, I will quote you an instance which will seem beyond belief. In a place about five miles from here there is a boiler and engine, which is operated by a negro, who has had no other experience in the line of handling boilers beyond his present position. One year ago, the boiler was blistered and upon the "engineer" hammering in the blister it developed a large crack in the plate. Now, to show you the grade of mechanics employed sometimes as engineers, I will relate the method used to repair the crack. To begin with, I will state that the feed water is taken from a creek, which is at all times very muddy, hence there is always considerable mud on the bottom of the boiler; taking advantage of the mud, the engineer simply jammed the crack as full of rags as he could from the inside, and permitted the mud to cement it tight. In order to prevent the burning of the rags, he put on an asbestos paste on the fire side of the crack. This boiler has been in operation in this shape for a year now, and for some reason or other it holds together.

We might well say that there is still room for the fool killer down this way, but I might say that this is only a sample of several districts of like nature that I have seen. In the large cities the laws protect the people against such cases, but in the country it seems that our legislators hold life at little value. It seems to me, that there should be the same protection afforded those persons in the country, that there is in the cities Sunny South.—"BALDHEAD."

* * *

The Handy Steam Trap

In the practice of steam engineering, there is no problem more vexing in its solution than that of caring for the water of condensation in the distribution system. An automatic trap is the device most generally employed, and among the myriad of devices offered, ranging from inadequate simplicity to complicated failure, there are many excellent traps, each having its advocates among intelligent users.

It is extremely doubtful, however, that any of them are infallible, and no doubt all of them have been condemned at times, for often a trap that has given satisfaction and reasonable service at one plant, has been rejected at another, where the working conditions are apparently similar.

With all the knowledge in view, it is not to be wondered at that the extravagant claims of infallibility advanced for some particular trap is met with an incredulous smile from the practical engineer.

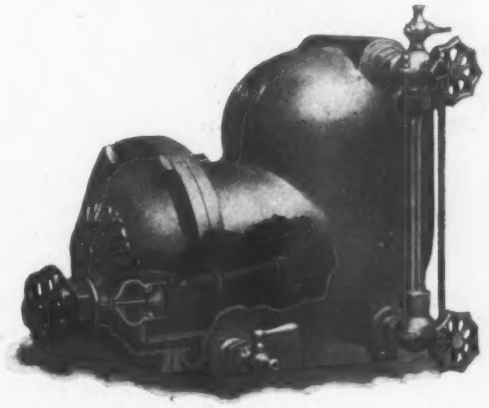
It is refreshing to find a manufacturer who is willing to admit that what they offer will ever need any repairs or attention, as the makers of the HANDY TRAP will admit. At the same time they do not permit it to be inferred that their device is equalled or exceeded in operation or durability by those offered by their competitors.

The trap, as shown in the accompanying drawings, has the familiar single seated, cone shaped, automatic valve, operated by a seamless ball float and bell crank, a type, probably, more universally used among successful traps, than any other known.

The most novel feature of the device is the ease with which it is possible to get at the valve mechanism to examine or repair it when occasion demands. And the arrangement which secures this advantage, also simplifies other necessary functions in a trap:—A discharge chamber is located in the head or cove, to which is attached all the working parts of the trap. The chamber has a by-pass which connects to the body of the trap, to which all the pipes are attached. The interior of the trap is shut off from the chamber by a positive valve of the globe construction, provided with the ordinary stem and bonnet; the seat of the automatic valve is located in this positive valve, which has a cage extending beyond its inner end, and a hole is

drilled in the stem to serve as a guide for the automatic valve, as well as locking it loosely in place, and preventing its becoming detached from the ball crank to which it is hooked. The automatic valve is of the ordinary cone shape, having a hook at one end, and a brass stem at the other. By turning the hand wheel of the positive valve, it can be drawn away from the automatic valve, and permit the trap to drain or blow away any matter that may clog or interfere with the normal working of the trap. Should this prove ineffectual, the steam can be shut off, and the bonnet and the positive valve removed; the automatic valve can then be unhooked from the crank pin, and withdrawn by the brass guide pin. This operation only requires the aid of a twelve inch wrench and the finger and can easily be accomplished in from two to five minutes time.

The seat is a hard metal bushing, and the cone valve is made



of the same material, to insure as long life as possible for these vital parts.

In the ordinary operation of the trap, there is a water seal of about three inches preventing waste of steam; a guage glass on

the side indicates at all times the working conditions of the valves.

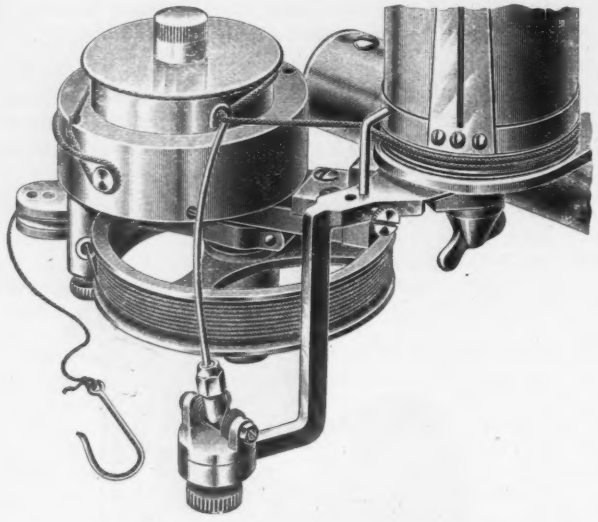
To the practical engineer, an examination will enable him to judge the true value of the claims of the manufacturers of the trap, chief of which is, that the simplicity of the valve mechanism makes it so convenient to inspect or repair that it is more likely to be done at once, thus preventing further waste.

As no bolts, gaskets or pipe connections are disturbed to get at the valve seat and valve, the claim will be more readily believed that not more than five minutes are required to complete the operation. And as the valve and seat are generally the only parts requiring attention, it seems quite probable that it will receive more prompt attention, as it is a self-evident proposition, that the easier a task the more quickly it will be performed. And when this condition is compared with the hours of hard and disagreeable work, with its attendant expense, to repair many makes of traps, it is quite probable that the latter task will be deferred for an indefinite period of time,and permit the waste to go on.

* * *

The Bushnell Take-Up Device

A new device for taking up the slack cord between the Steam Engine Indicator and reducing motion, when using detent or drum stop on the indicator is illustrated by the engravings herewith, one of which shows the appliance full size, while the other shows it applied to an indicator and in the act of taking up the slack on return stroke of engine. The arm with eye in the end is under a slight constant tension caused by the wound spring at the base of the arm. When the indicator is in use, the tension on the cord is sufficient to overcome the tension on the arm, so that



it is held in a position close to the base of the indicator paper drum, thus allowing the cord to pass freely to the reducing wheel. When the motion of the paper drum is stopped by the detent, the arm moves out and takes up the slack cord. This device is so made that it is susceptible of different adjustments so that it can be applied to any of the standard makes of Indicator, either right or left hand, and either 1¾ inch or 2 inch paper drum.

Further information can be obtained from the manufacturers. The JOHN S. BUSHNELL CO., 126 Liberty Street, New York.

A Successful Inventor and His Work

In making the selection of a steam boiler more consideration, talent and scientific knowledge is required than is necessary for the entire balance of the plant. With the present type of Corliss engine we have attained about the acme of economy in the engine room; hence we must perforce return to the boiler room for still greater economies, if such is desired.

The 20th Century has developed high steam pressures in the effort to attain this economy. But, with the high pressure comes the demand for boilers of such mechanical design, material and construction as will preclude all chance of violent eruption. That method of construction in force a number of years

E. J. Moore

ago cannot be expected to be adequate to the present demands.

The value of high pressure in the line of economy can not be over-estimated, especially where compound the engines are used. It has become a recognized fact that the sectional boiler is to all purposes the only logical type to use where the pressures range very much above a hundred pounds. But, because a boiler is a sectional boiler is no criterion that it is a safe, nor yet economical boiler. It seems to be the idea of some people that the boiler that boiles water the fastest and can be made up the cheapest, so long as it is in sections, is the best boiler; but this is not the case. For this reason, then, it becomes necessary for the purchaser to have an experienced advisor at hand when contemplating placing orders for boilers. The accompanying illustrations show an engraving of Mr. E. J. Moore, of the E. J. Moore Foundry and Machine Co., 2227-2233 Wood street, Philadelphia. Mr. Moore is the practical founder of the water tube boiler, and it is to him that we owe largely the high degree of efficiency of many of the leading types of sectional boilers now in use—many of his patents being the fundamental basis of their construction.

He is now manufacturing the Improved Moore Water Tube Boiler, the following description of which will no doubt be of interest and value to engineers and others.

In this boiler will be found freedom from rupture, immunity from explosion, economy of fuel, a perfect circulation, and easy access to accomplish the necessary cleaning, combined with a perfect system of providng for the expansion, which is so costly to the life of most sectional boilers. Figure two illustrates the method used to take up the expansion in the headers. Instead of the entire range of tubes being expanded into one single casting, in the Moore Boiler, they are expanded three tubes into a section and then each section is in turn joined by expanding the short nipples shown into each section.

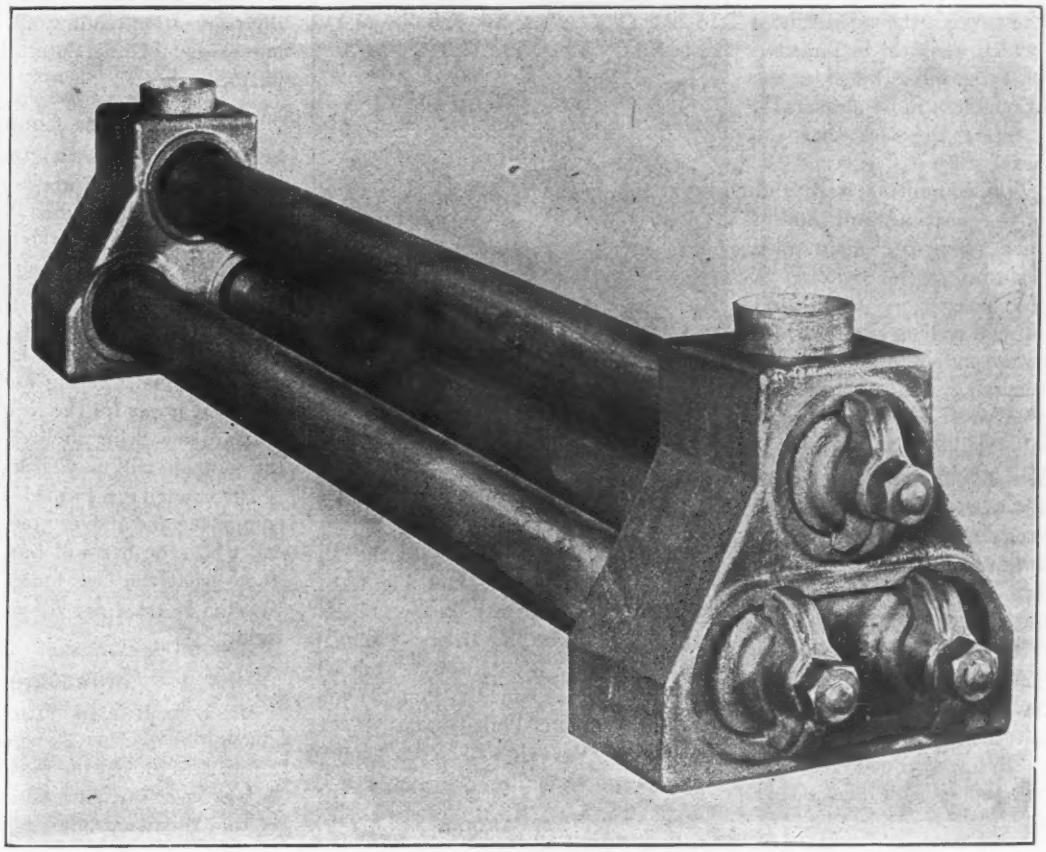
By increasing the thickness of plates in the drums steam pressures can be safely carried on the boiler up to 300 lbs. They will relieve at 350 pounds and close at 310 pounds, and keep tight at the latter pressure. Any one can see the utter impossibility of exploding this boiler by internal pressure of any kind. The plates will relieve at the rear end first, as there are four pounds more pressure there on account of the height of the column of water in the boiler. The sections are clustered together, five wide and four high, and are united to a large saddle in front by means of expanding nipples or short tubes, so that very little friction retards the flow of the intrained water and steam in their passage to the upper drums to complete the round of circulation. These saddles are riveted to the upper drums on the under side back from the heads; the interior of the saddle is open full size, except that the openings are ribbed o r strength. There is another saddle at the rear end, situated back from the heads of the steam-and-water drum, having a sufficient number of circulating tubes expanded therein and connected by expansion to the back sections. This construction gives a free run of all the sediment down to the mud drum or lowest point of the structure.

The upper horizontal drum for 100 horse-power is thirty-six inches in diameter by nineteen feet long, made of open hearth steel, five-sixteenths of an inch thick, horizontal seam, double riveted heads one-half inch thick, dished to the radius of the diameter of the drum.

There are no cast-iron heads, braces or stays in its construction, except a man-hole plate, sixteen inches by eleven, to give access to the interior.

The whole boiler is erected on wrought-iron columns and channels; the columns are fitted into cast-iron base plates, twenty-four inches by twenty-four inches, with flanges that overlay their foundations, and thus secure the brick side-walls in position; the over-head channels are connected to the column by means of caps and bolts. Between these channels, eyebolts with links extend down on each side of the drum; the links are passed over trunnons or hooks that are riveted to the side of the drum. This arrangement for the suspension of the whole steam boiler, with its weight of water and material, is so evenly distributed that when the boiler is erected and filled with water, and ready to be tested before bricking in, it is so sensitive to touch that the whole structure can be moved by one hand. By this link motion expansion and contraction are well provided for, and this prevents rupture.

Catalogue and further description can be had from the above address.



Illustrating the Moore Header

Society News

American Order of Steam Engineers

Fifteenth Annual Convention of the Pennsylvania Grand Council, A. O. S. E.

To the entertainment Committee appointed by the Philadelphia Councils, A. O. S. E., to look after the pleasure and welfare of the Pennsylvania Grand Council delegates, can be given the well earned credit of making the 15th Annual Convention, which was held in Philadelphia on March 17th and 18th last, of the State Grand Council, a most pleasurable occurence. Despite the fact that the Convention was called to meet on St. Patrick's Day the committee were able to arrange for the most pleasant kind of weather, which happily maintained throughout the stay of the visitors. A feature of this meeting of the Grand Council was the expediency with which the business was conducted, all unnecessary speech making and preliminaries being dispensed with.

At ten A. M., Tuesday, the meeting was called to order By Grand Chief Trout. With the fall of the gavel commenced at once the regular business of the day and was continued until the business of the meeting was entirely disposed of.

The election of officers to serve during the ensuing year resulted in retaining in office the same members who so ably conducted the work of the Grand Council for the past year, with one exception, that of H. F. Shirley, who was elected to the place of Grand Outside Sentinel.

The Roster of officers follows:—Grand Past Chief Engineer, A. P. Driesbach, Allentown. Grand Chief Engineer, Hiram Trout, Reading. Grand First Assistant Engineer, John J. Kelly, Philadelphia. Grand Senior Master Mechanic, W. J. Courtney, Columbia. Grand Junior Master Mechanic, J. J. Nolte, Columbia. Grand Recording Engineer, A. L. Keppelman, Reading. Grand Corresponding Engineer, Fred Markoe, 931 Orianna St, Philadelphia. Grand Financial Engineer, W. J. Gifford, Philadelphia. Grand Treasurer, William J. Beatty, Manayunk. Grand Inside Sentinel, Aaron Buck, Sunbury. Grand Outside Sentinel, H. F. Shirley, Pottstown; Grand Trustee, Edward Riker, Philadelphia.

Representatives to the Supreme Council meeting at Pittsburg, on May the 8th and 9th, Hiram Trout Reading; A. L. Keppleman, Reading., A. P. Driesbach, Allentown C. W. Leng, Philadelphia; S. J. Calloway, Philadelphia; William Wetzler, Philadelphia; W. J. Eccles, Philadelphia.

Hiram Trout
Re-elected Grand Chief Engineer, A. O. S. E. of Penna.

The alternating delegates to the Supreme Council are: James Lightfoot, Philadelphia; William J. Beaty. Philadelphia; Franklin R. Moore, Philadelphia; George Richardson, Philadelphia; George Kennedy, Philadelphia; William Connor, Philadelphia; C. P. Williams, Philadelphia. York Council was not represented.

The Banquet

This feature of the entertainment was conducted in a pleasing manner and will long remain in the minds of the visiting delegates and their friends—about 300 altogether—as one the most pleasing incidents of their sojourn in Philadelphia.

Preliminary to the seating of the guests Mr. John Lukens, Chief of the Philadelphia Boiler Inspection Department, made a masterful address in a few well chosen words upon the work done by his department since the inception of the Philadelphia License Law. Mr. Luken's words were complimentary of the earnest co-operation the Order had accorded him in his efforts to do his work efficiently. His comparison of the conditions existing four years ago and at the present time in this city elicited the most hearty applause. Mr. Luken's address was followed by an earnest endeavor upon the part of all present to show an appreciation of the very excellent dinner provided. Immediately following the coffee and cigars a vaudeville entertainment was introduced to assist in making the last moments of the Convention a pleasing recollection.

The "finale" was tendered by Grand Corresponding Engineer Mr. Fred Markoe, who eloquently thanked those present for their assistance during the work of the convention, ending up with a pleasing eulogy of the Entertainment Committee.

Delaware Council

Mr. A. E. Deakyne, the ever genial and enterprising Corresponding Engineer of Delaware Council No. 1, of Wilmington, Del., informs us that Delaware Council is booming along at good clip, having initiated eight new members during the past month, with several more to follow. There is good attendance at every meeting and the Council has great hopes for the future. New by-laws are now being adopted and in future the council will pay sick benefits.

The council has formed a "buzy bee" committee and at every meeting the boys ask when the bee will buz. We do not know what the bees buzes for, but Bro. Stayton is treasurer zo, we guess it's all right.

Milwaukee

Mr. L. L. Rice, of "The Practical Engineer," had the pleasure of visiting Milwaukee during the past month, where he was pleasantly entertained by members of the American Order in that city. C. P. Williams Council is exceedingly prosperous and taking in new members at every meeting. The council has changed their place of meeting to Lodge Hall on East Water St. where they meet every Monday evening.

The new officers of this council recently installed are:—Chief Engineer Elmer Towers; First Assistant Martin Nelson; Recording Engineer, J. T. Harris; Financial Engineer, Frank Trozel; Senior M. M., H. Hothbohm; Junior M. M., F. H. Hayes; Chaplain, A. Nothbohm; Inside Sentinel, H. Willis; Outside Sentinel, E. Bluret; Trustees, F. Caldwell and J. Casper; Delegate, J. T. Harris.

After the installation ceramonies, which were conducted by Deputy Supreme Chief Harris, assisted by Past Chief Engineer D. T. Richardson, all the boys repaired to the St. Charles Hotel, where a banquet had been arranged and following which the party were entertained by Myers & Livrights Band. after which brother Casper delivered an interesting lecture on Superheated Steam; then Brother Richardson sang Auld Lang Syne which ended a most enjoyable evening.

The Coming Pittsburg Convention

Out in Pittsburg, the boys of Iron City Council, No. 21, are getting ready for the Supreme Council Convention to be held there the week of May 11th next, and the indications are that they will show all the visitors a jolly good time.

The arrangements for hotel accomodations, for an exihition of supplies and celam specialties, for a banquet for the de egates and their friends and for a store of others things have already been completed and the arrangement thus far would be hard to improve upon, even Lou Vandegrift is loaded up with pockets full of tricks to spring upon the unsuspecting visitors, while Hamilton, Rose, O. Sullivan, Sulton, Johnson and others are concocting schemes to furnish a different variety of entertainment for every fancy, and in this the natural advantages of the city will aid them greatly, for Pittsburg is truly a great city and unusually interesting both geographically, commercially and socially. To those who have never visited Pittsburg the trip will be an especially pleasant one, while those fortunate enough to have been there before will find new pleasures, and many improvements to interest and please them.

The committee in charge of arrangements are going to make quite a feature of the exhibition of supplies and steam appliances. The main exibition room is large and well lighted and the various goods exhibited can be shown to good advantage. It is the intention of the committee to keep the exhibition hall open evenings, and to invite all Pittsburg engineers to visit them.

Further inforamation regarding space, charges, etc., may be had by addressing Frank C. Rose, 10 Federal St., Pittsburg, Pa.

Kensington Council

Kensington Council, No. 3, A. O. S. E. of Philadelphia, has inaugurated a new movement and one that is likely to prove decidedly beneficial to all concerned. They have made the position of official instructor an elective office with asalary, and have elected their old instructor, Chas. Cook, than whom there is none better. Mr. Cook's ability as an instructor is so well and widely known that many engineers will be glad to know that Kensington Council, has now decided to make their first Thursday night meeting in every month an open meeting, to which all engineers, not members of the order, are invited. Those who appreciate good educational advantages will not fail to attend. Remember the first Thursday evening of each month. Frankford Ave. & Master streets.

Old Colony Council

At their regular meeting, on Feb. 14th, Old Colony Council, No. 14, of Rockland Mass., installed the following officers to serve for the ensuing term.: Chief Engineer, Herbert W. Jones; First Assistant, Thos. W. Sharpe; Recording Engineer, C. W. Allden; Corresponding Engineer, Jas. K. Sedgwick, Box 333 Rockland; Financial, Geo. S. Davenport; Treasurer, Chas. Scott; Chaplain, C. Frank Bosworth; Sr. M. M., Joseph Bryant; Jr. M. M., Arthur Torrey; Inside Sentinel, Francis Caldwell; Outside Sentinel, D. S. Inglie; Trustees, Herbert W. Jones, L. Q. Prentice and E. H. Naylor; Delegate to Supreme Council, W. E. Packard.

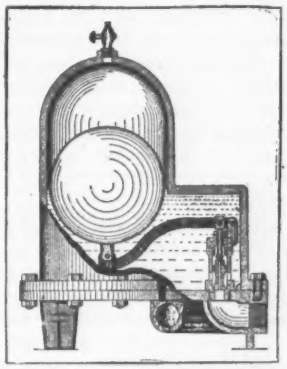
Energy Council, Baltimore

At the regular meeting of Energy Council, No. 2, of Baltimore, Md., December 31st, the following officers were elected:

Chief Engineer, T. E. Eaton; Assistant, J. W. Lutz; Recording Engineer, James H. Stallings; Corresponding Engineer, Thomas O. Daneker; Financial Engineer, Harry L. McGee; Treasurer, Charles L. Schirmer; Chaplain, P. A. Kirkwood; Senior M. M., Fred L. May; Junior M. M., J. L. Worton; Inside Sentinel, Alfred R. Sloman; Outside Sentinel, J. W. Sabines; Delegate to Supreme Council, Philip Kirkwood.

After the election Brother Henry M. Statz presented Brother Philip A. Kirkwood, the retiring Chief Engineer, with a souvenir gavel, Bro. James H. Stallings with a model of a book, and Bro. Harry L. McGee with a cannon, all made of wood taken from the flooring of the White House at Washington during its recent improvement.

Our local readers as well as many others who are acquainted with Mr. Chas. E. Carpenter, general manager of the large Philadelphia engineer's supply house of E. F. Houghton. & Co. has now almost recovered from his recent serious illness.



A GOOD THING

The "FORD" Compound Steam Trap

We want you to take hold of it. Made in 5 sizes. Has large outlet and the largest capacity of any Steam Trap on the market.
Write for full particulars and prices.

Thomas P. Ford Co.

SCHADE & MARSHALL
PHILA. AGENTS
319 HARRISON BUILDING PHILADELPHIA, PA.

No oil lubricant is a perfect lubricant for heavy machinery. A solid lubricant is required. No solid lubricant is at once so durable and so smooth as Ticonderoga Flake Graphite. Only Ticonderoga Flake Graphite is used in Dixon's Graphite Lubricant. Ask for booklet 96 c.

Joseph Dixon Crucible Company, Jersey City, N. J.

TRADE NOTES

The "Selden" packing which for the past year has been put up in boxes is proving popular with both the dealer and consumer. It makes a pleasing appearance in the stock room and keeps in better shape in the Engineer's locker. The cover of each box, on it a label bearing a cut of the packing with the name across it, as shown in our advertising columns. No charge is made for the box. Selden Packing is manufactured by Randolph Brandt, 38 Cortland St., New York.

The Sands Mfg. Co. , corner of Market and Bayard Sts., Allegheny, Pa., are making rapid strides with their patent steel brazed oilers and torches. By the Sands' method of making the oilers there is no possibility of the can leaking oil all over everything, when it gets heated. A very interesting and instructive catalogue will be sent free to the readers of the Practical Engineer.

Larkins self-lubricating rod packing is said to be meeting with marked success in some very severe tests. This packing is composed of the finest quality metals granulated in hardness to withstand great frictio and wear, and thoroughly incorporated with graphite, which allows it to take up new. adjustment under slight pressure of gland. An illustrated pamphlet will be mailed to any one writing the Penna. Electrical & Railway Supply Co., 23 Imperial Power Bldg., Pittsburg, Pa.

It was an Engineer who invented the Weinland Tube Cleaners, that's what make the cleaner so popular among engineers, and keeps the Lazonda Mfg. Co., of Springfield, Ohio, so buisly filling orders. Mr. Weinland knew from years' experience as an engineer what was needed in this line, and he built one, and no whis Company is building thousands.

Further information concerning this exceptional assistant to an Engineer, gladly furnished free to anyone addressing the above Co."

Beltine is a comparitively new Belt dressing, that is, it is somewhat new to belt users in this country, though for years it has been more extensively used than any other in Europe. The American manufacturers of Beltine, is The Beltine Mfg. Co., 53 and 55 West Jackson Boulevard, Chicago. This company has now been in business for a little more than a year, during which time, they inform us that they have secured the patronage of about 250 large consumers in Chicago alone, and many in other places, in all of which it has given the greatest possible satisfaction. Among their customers are such concerns as the Crane Co., Elgin National Watch Co., Pullman Co., and many others. This dressing can be used with equal success on either leather, canvass or rubber belts, and will not injure any kind of belt, but will benefit every kind.

The marvelous success of the concern in a short time seems to indicate that the dressing is all that the makers claim.. Further information can be had from the Company. Write for circulars, mentioning the "Journal."

"Smokeless Combustion," issued by the Duluth Stoker Co., Duluth, Minn., contains a very well ilustrated description of the DuluthMechanical stoker. To those interested in such matters, or those intending to purchase stokers of this type, it will well repay the trouble taken to secure a copy of the book. A postal request with mention of this paper will elicit a prompt reply.

The Excelsior Elevator Co., Heed Building, Philadelphia, attending the very successful institution of the Elithorpe Air Cushion in the 500 foot tower of the Philadelphia City Hall, are experiencing a great demand for the installation of similar cushions in many of the leading buildings of this country. A principal feature of the Company's business is their ability to handle any kind of repair work, analagous to the elevator business at a moment's notice, all parts of the leading makes of machines being kept in stock.

The Main Belting Co., of 1229 Carpenter St., Philadelphia, announce that it has opened its New York office in the Mutual Reserve Bldg., 309 Broadway, New York, Room 913. The new office will be in position to fill orders for Leviathan Belting promptly.

IF ENGINEERS will send $1.00 to the address below they will receive two blue prints, with tables and instructions, showing how to set valves and eccentrics on Corliss engines, simple and compound, with one and two eccentrics. JOHN T. LINDSTROM, 440 Liberty Street, Allentown, Pa.

The Engineering & Equipment Co., recently organized in Pittsburg, Pa., with offices in the Bissell Block, desire manufacturer of Electrical & Mechanical supplies, to mail them catalogues, addressed to "Department K."

Mr. Colin McInnes, for some years Supt. of the Anchor Engineering and Machine Co., Pittsburg, Pa., has accepted a position with James

Mr. Colin Innis

Bonar & Co., Inc., the well known steam specialty manufacturers, as Supt of their new machine shop and brass foundry now in course of construction. McInnes is a mechanic of unquestioned ability and well fitted to have charge of the manufacture of the high grades of steam specialties manufactured by Messrs. Bonar & Co.

A BELT DRESSING WITHOUT A "WEAK SPOT"

Endorsed by over 8000 of the Largest Firms in the World

AS OTHERS SEE IT

ELGIN NATIONAL WATCH COMPANY
Elgin, Ill., Feb. 13, 1903.

The Beltine Mfg. Co., 53-55 W. Jackson Blvd.

Gentlemen:—Replying to your inquiry, under date of the 11th inst., we beg to advise that we have been users of Beltine for more than two years, beginning some time before the receipt of your half-gallon sample. We like it very much, and shall continue to use it to the extent of our requirements.

Yours truly, ELGIN NAT'L WATCH CO.
GEO. E. HUNTER, Sup't.

A trial will convince the most sceptical, and it is sent on approval. Write us

THE BELTINE MFG. CO.

53 and 55 West Jackson Blvd., CHICAGO

Eastern Agents Wanted

ASK THE ENGINEER

how much a month you are paying for oil. Divide that sum by two, and remember that we positively guarantee that our

CROSS OIL FILTER

will save you that much money.

Try a filter for thirty days, and if the saving does not amount to at least 50 per cent. of your oil bills, send the filter back at our expense.

"The Cross Oil Filter has been a good investment. It pays for itself every four months."
Middlesborough (Ky.) Waterworks.

Write to-day for our booklet.

THE BURT MFG. CO., AKRON, O., U.S.A.

Largest Manufacturers of Oil Filters in the World.

Supplied also by Oil Companies, Engine Builders, and Power Contractors.

James McCrea & Co., Chicago, Mfrs. of Steam Specialties, report that 1902 was by far the banner year they have ever experienced, even with placing four new specialties on the market, consisting of the H. H. Steam Trap, which has filled the place for a trap that is simple in operation and reasonable in price, the Butman Flue Cleaner Rod, Century Gasket & Washer Cutter, and the Century Drilling Machine. All of their specialties are shown in their new catalogue, recently issued. The sales of the Climax Steam Joint Clamp were more than double 1901 and a complete stock of them are carried by the following dealers throughout the United States:— New York, Geo. I Roberts & Bros.; Boston, A. W. Chesteerton & Co.; Philadelphia, Barrett & Plowman; Syracuse, Edward Joy; Pittsburg, Kelly & Jones Co.; Cleveland, W. M. Pattison Supply Co.; Detroit, Muzzy-Lyon Co.; Indianapolis, Knight & Jillson Co.: Cincinnati, Crane-Hawley Co.; Louisville, Laib & Co.; St. Louis, Western Iron & Supply Co.; Milwaukee, Robert Rom Co.; St. Paul, Western Supply Co.; Kansas City, U. S. Water & Steam Supply Co.; Omaha, U. S. Sup ply Co.; Denver, Mine & Smelter Supply Baltimore, J. B. Adt; Atlanta, Cotton States Co.. Belting & Supply Co.; Birmingham, Echols-Smith Hdw. Co.; New Orleans, The Fairbanks Co.; San Francisco, The Plant Supply Co.

Mr. Chas. S. Prosser has been appointed general sales agent of the Peerless Rubber Mfg. Co.

Mr. Prosser is fully qualified for such a position, having been five years in the factory, and five years as traveling salesman for the Peerless Rubber Mfg. Co.

The Sims Co., Erie, Pa., on account of the expansion of their trade have again found it necessary to enlarge their plant, adding new tools, etc. Their Feed Water Heater is becoming very popular with steam users. As an evidence of their growing trade in Oil Filters they report having shipped eleven to Philadelphia alone during the week ending March 21st.

The Cherry Chemical Company, manufacturers of the Red Seal Boiler Compound, have been compelled to enlarge their quarters in the Heed Building, 1215 Filbert St., Philadelphia, on account of the increase of business.

They analyze scale and water free of charge for their customers; the only thing they require is to send them one gallon of water, by express, prepaid, or about two ounces of scale, by mail, and they will do the rest.

By making an analysis they determine the quality of Compound you should use in order to remove the scale.

They are always ready to answer any questions of those interested.

A Catalogue that gives all necessary information about sizes, capacities, and prices is of some use to an engineer. Such a catalogue is issued by the National Pipe Bending Co., 157 Lloyd St., New Haven, Conn., describing the National Feed water Heater. Copies will be sent to any one interested. Mention this paper

---

Coal. There is probably no other coal dealer in Philadelphia, who lived up to his contract during the big strike, like Andrew Crawford, 1829 North 10th St. Mr. Crawford is therefore entitled to special consideration at the hands of the engineers who used steam coal. He makes a specialty of furnishing high grade steam coal, and enjoys an excellent reputation among the manufacturers and engineers who patronize him. If any of our readers are dissatisfied, they will do well to give him a trial.

Thompson's Soot Ejector admits no steam into the tubes of your boiler, but removes the soot effectually and sends it up the tack where it belongs. Thompson's shaking, dumping and stationary grate bars, the Bachlder indicator, the Spencer damper regulator and other interesting steam specialties, are all illustrated and described in the Catalogue "K" of Richard Thompson & Co., 120 Liberty St., New York. A copy will be sent to any of our readers, upon request.

Dunham's Drain Valve and Steam Trap, manufactured by C. A. Dunham Co., Marshalltown, Iowa, is operated automatically by contraction and expansion, due to change of temperatures. It is but little larger than an ordinary globe valve. Its discharge capacity is equal to the area of the intake pipe, and it is claimed that it closes promptly when the water has passed off, thus preventing any loss of steam. The Company have issued quite a comprehensive circular illustrating and describing it, which they will be pleased to send to engineers mentioning this "journal."

The Ford Pump Regulator. The Ford "compound" steam trap and many other specialties manufactured by the same company, are effectively illustrated and described in their catalogue. These goods are carried in stock by Schade & Marshall, 319 Harrison Bldg., Philadelphia. Catalogues and further particulars will be sent by them to any one interested.

A Large Sample Can of Keystone Grease and a Keystone Brass cup will be sent free of charge, express prepaid, to any part of the world, to engineers or steam users who wish to give it a trial and prove its wonderful lubricating qualities. The Company is glad to send these samples to persons who will give their grease a fair test; for their experience has been, that about 99 per cent. send back for more grease. When sending for sample, address Keystone Lubricating Co., 20th & Allegheny Avenue, Philadelphia, mentioning this "journal."

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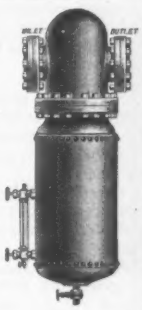
For Live or Exhaust Steam



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One of our 12 Styles—a right Separator for every service. Thirty days' trial allowed.

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A high grade engine of 500 horse-power costs in the neighborhood of $5,000. A

COCHRANE STEAM SEPARATOR

of sufficient size for such an engine, and a trap to automatically drain the Separator, cost about $150.

Interest on the investment of $150 at 7½% would make an annual premium of only $11.25 for $5,000 engine insurance.

But as a matter of fact, the increased engine efficiency from the use of dry steam, and the saving of oil, due to the better lubrication obtained when dry steam is used, more than pay the premium and leave a balance which in a few years pays for the initial cost of the outfit.

An interesting proposition—isn't it?—when looked at in the right way.

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Manufacturers of Cochrane Feed and Water Heaters.

American Order of Steam Engineers.

ORGANIZED APRIL 27, 1886.

An Order of Engineesr for Engineers and Engineers only.

DECLARATIONS OF PRINCIPLES

Believing that ability will bring its full value in this country, this Order shall at no time take part in strikes, nor in any way interfere between employer and employees. Recognizing their identity of interests, it shall take no part in any project or enterprise that shall interfere with perfect harmony between them; neither shall it be used for political or religious purposes.

These principles shall not be amended or repealed except by unanimous vote of the Order.

Any member who shall be guilty of violating the principles of the Order shall be expelled.

OBJECTS.

First.—To promote a more thorough knowledge in its members of theoretical and practical steam engineering.

Second.—To assist members to obtain employment.

Third.—To help the sick, injured and distressed and bury the dead.

Fourth.—To establish a Widows' and Orphans' Fund.

Fifth.—To help members who shall become incapacitated from following the profession to obtain employment suited to their affliction.

Sixth.—To do our utmost to extend the license law throughout the United States.

Seventh.—To establish schools in which our members may study the highest branches of steam engineering.

MEMBERSHIP.

An applicant for membership must be an engineer between twenty-one and fifty years of age, and must be a white male citizen of the United States, of good moral character and be a believer in the Supreme Being, and be free from all physical infirmities.

He must have had three years' service in an engineering department, or if a machinist, or graduate of a technical institute, then one year's service, in such department, and in localities where engineers are required by law to be licensed, they must have such license, and must satisfy the investigating and examining committees of the council to which he applies as to his character and ability.

LIFE MEMBERSHIP.

Engineers who have passed the age limit may be admitted to life membership. They must possess the same qualifications and pass the same examination as are required in the next proceeding clause: They shall be entitled to all rights and privileges of the Order except they cannot vote on financial questions or for the election of officers or be entitled to any sick or death benefits.

DIRECTORY.

The Publication Committee of "The Practical Engineer" desires that the Corresponding Engineers of all Councils of the American Order of Steam Engineers send the name of their Chief Engineer and their own name and address, together with the time and place of meeting, to the Secretary of the Publication Committee immediately after each election of officers. Address J. C. McDowell, Secretary, in care of "The Practical Engineer," 1215 Filbert Street, Philadelphia.

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Delaware Council, No. 1, meets every Wednesday at S. E. Cor. Fourth and King Sts. Chief Engineer, Harry W. Sherman. Corresponding Engineer, A. E. Deakyne, 406 Lombard St.

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JENNINGS.

Jennings Council, No. 2, meets every Saturday evening in American Bank. Chief Engineer, Daniel R. Jones. Corresponding Engineer, R. E. Funk.

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Deputy Supreme Chief Engineer, A. J. Deidrich, 226 North Caroline St., Baltimore, Md.

BALTIMORE.

Maryland Council, No. 1, meets 2nd and 4th Fridays in Royal Arcanium Hall. Chief Engineer, Geo. Goodwin. Corresponding Engineer, Wm. S. Smith, 533 Sharp St., Baltimore.

Energy Council, No. 2, meets every Wednesday of each month in Bauer Hall, Chesapeake and Elliott Sts. Chief Engineer, T. E. Eaton. Corresponding Engineer, Thos. O. Daneker, 834 East Ave.

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Deputy Supreme Chief for Eastern District, W. E. Packard, Whitmann.

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Boston Council, No. 4, meets 2nd and 4th Thursdays of each month, in Templar Hall, 724 Washington St. Chief Engineer, A. R. Abbott. Corresponding Engineer, Phillip Sanford.

ROCKLAND.

Old Colony Council, No. 14, meets 2nd and 4th Saturdays in the American Foresters' Hall. Chief Engineer, Herbert W. Jones. Corresponding Engineer, James K. Sedgwick, Box 333, Rockland, Mass.

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Stevens Council, No. 1, meets 3rd Saturday, at Water, near Lafayette St. Chief Engineer, Lawrence Oliver. Corresponding Engineer, James H. White.

CAMDEN.

Camden Council, No. 3, meets every Thursday evening at N. E. Cor. Second and Federal Sts. Chief Engineer, C. H. Harigle. Corresponding Engineer, C. H. Pfeiffer, 571 Berkley St.

ATLANTIC CITY.

Atlantic City, No. 4, meets every Tuesday evening at Merchants, Cor. Atlantic and New York Aves. Chief Engineer, Wm. Fowden. Corresponding Engineer, W. S. Price, Haddon Hall.

BRIDGETON.

Bridgeton Council, No. 5, meets every Friday. Chief Engineer, David Sellers. Corresponding Engineer, Francis O. Garrison, Bridgeton, N. J.

MILLVILLE.

Millville Council, No. 6, meets every Saturday, 7.30 P. M., in G. A. R. Hall, East Main St. Chief Engineer, Geo. Esabel. Corresponding Engineer, Lewis Doughty, 604 Mulberry St.

NEW YORK.

SYRACUSE.

John E. Sweet Council, No. 6, meets Monday, Room 23, Nottingham Block, East Washington St. Chief Engineer, John Cunningham. Corresponding Engineer, S. A. Steel, 311 Orange St.

PENNSYLVANIA.

Grand Chief Engineer, Hiram Trout, 1042 Locust St., Reading, Pa. Deputy Grand Chief for Philadelphia and Delaware Counties, John P. Rickards, 2707 N. Broad St., Philadelphia. Grand Corresponding Engineer, Frederick Markoe, 931 Orianna St., Philadelphia.

Deputy Grand Chief for Western Pennsylvania, A. D. Hamilton, 2025 Forbes St., Pittsburg, Pa.

PHILADELPHIA.

Germantown Council, No. 22, meets every Wednesday evening at Main and Seymour Sts., Germantown. Chief Engineer, L. F. Souders. Corresponding Engineer, Frank MacIndoe, 3529 Ainslie St., Falls of Schuylkill, Philadelphia.

Welcome Council, No. 2, meets every Friday, N. W. Cor. Twelfth St. and Columbia Ave. Chief Engineer, Paul Pieling. Corresponding Engineer, L. D. Woodington, 2428 N. Bancroft St.

Kensington Council, No. 3, meets every Thursday, at A. P. A. Hall, Frankford Ave. and Master St. Chief Engineer, C. W. Leng. Corresponding Engineer, Ernest Ritsert, 2229 Frankford Ave., Philadelphia.

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The saving you make by having one in use will pay for it before used a month. Guaranteed to repair every make and all kinds of valves without disconnecting them from the pipe. Low in price. Easily operated. Ask for catalogue and prices.

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illustrated here is designed for Single Engines or Large Plants where many Engines are operated from one steam main. It will oil one or a dozen Engines, save 40 per cent. of Oil used with any other Lubricator, and prevent annoying leaks in Steam Pipes.

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For every Sunday you are here,
At work on that old packing.
Now here's an ad. that makes me glad,
It says, Use P. P. P.,
For saving time and coal it's prime,
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is the original "wedge packing," totally different in principle from all others (except the imitations which infringe our patent, and which you'd better not use). Its sliding wedges adjust themselves to the rod with the least possible pressure. It saves power, saves packing, saves labor.

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Philadelphia Council, No. 7, meets every Wednesday, at Kenny's Hall, N. W. Cor. Broad and Filbert Sts. Chief Engineer, W. G. Richards. Corresponding Engineer, W. S. Wetzler, 3717 Aspen St.

Manayunk Council, No. 9, meets 2nd and 4th Friday evenings in Temperance Hall. Chief Engineer, John Hill. Corresponding Engineer, John Clevenger, 211 Lofty St.

Helping Hand Council, No. 12, meets every Thursday evening at Kensington Ave. and C St. Chief Engineer, Edward Laurence. Corresponding Engineer, Frank McHugh, 2503 Tulip St. All correspondence should be addressed direct to the Council.

Municipal P. F. D. Council, No. 20, of Philadelphia, meets the second Thursday of each month at Odd Fellows' Hall, Third and Brown Sts. Chief Engineer, Frederick Markoe. Corresponding Engineer, Walter Meyers, 1211 North Howard St.

PITTSBURG.

Iron City Council, No. 21, meets every Saturday at Arnfeld Hall, 1119 Penn Ave. Chief Engineer, Phillip W. Sutton. Corresponding Engineer, F. C. Rose, 10 Federal St., Pittsburg, Pa.

GIRARDVILLE.

Girard Council, No. 8, meets every Tuesday evening at O'Neill's Hall, Second and Ogden Sts. Chief Engineer, Jacob Weber. Corresponding Engineer, M. J. Carey, Lock Box 214.

ALLENTOWN.

Lehigh Council, No. 15, meets every Wednesday evening at 639 Hamilton St. Chief Engineer, John Durrin. Corresponding Engineer, A. P. Driesbach, 728 Chew St.

POTTSTOWN.

Pottstown Council, No. 14, meets 1st and 3rd Saturday evenings at P. O. S. of A. Hall, Cor. High and Hanover Sts. Chief Engineer, Wm. Rickert. Corresponding Engineer, H. L. Shirey, 362 Cherry St.

READING.

Progress Council, No. 13, meets every Saturday evening at Diebert Hall, Ninth and Penn Sts., Room 4. Chief Engineer, A. B. Hess. Corresponding Engineer, Frank S. Miller, 3 West Franklin St.

CHESTER.

Delaware County Council, No. 6, meets every Wednesday evening in the Carpenter Hall, Sixth and Wall Sts. Chief Engineer, John Canavan. Corresponding Engineer, E. E. McCoy, 2222 West Third St.

YORK.

York Council, No. 16, meets every Wednesday Evening in the Jordan Block. Chief Engineer, A. L. Bair. Corresponding Engineer, Walter H. Long, 23 East Philadelphia St.

HARRISBURG.

Capitol City Council, No. 17, meets every Tuesday evening in Red Men's Hall, Market St., above Second. Chief Engineer, B. H. Shafer. Corresponding Engineer, S. Filson, 1126 Market St.

COLUMBIA.

Columbia Council, No. 18, meets every 1st and 3rd Saturdays, in Odd Fellows' Hall. Chief Engineer, Amos Simmons. Corresponding Enginner, W. J. Courtney, 804 Walnut St.

SUNBURY.

Sunbury Council, No. 19, meets every Monday evening in Zartman's Hall. Chief Engineer, H. E. Culp. Corresponding Engineer, Ed. Schrieber.

WISCONSIN.

Deputy Supreme Chief Engineer, Joseph P. Harris, No. 1611 Clybourn St., Milwaukee.

MILWAUKEE.

Washington Council, No. 1, meets every Saturday at 207 Grand Ave. Chief Engineer, J. B. Chambers. Corresponding Engineer, James A. Rigby, 136 Reed St.

Clifford P. Williams Council, No. 2, meets every Monday evening at Lodge Hall, E. Water St. Chief Engineer, Elmer Towers. Corresponding Engineer, Joseph T. Harris, 1611 Clybourn St.

TENNESSEE.

Deputy Supreme Chief Engineer, John B. Mullen, 826 Central Ave., Nashville.

NASHVILLE.

Enterprise Council, No. 1, meets every Friday evening in the Twin Building on Cedar St. Chief Engineer, J. J. Johnson. Corresponding Engineer, Jno. B. Mullen, 209 Jackson Building.

OREGON.

Deputy Supreme Chief Engineer, Nat. Freese, Grant's Pass, Oregon.

GRANT'S PASS.

Oregon Council, No. 1, meets every 1st and 3rd Saturday in A. O. U. W. Hall, Main St. Chief Engineer, William H. Kenny. Corresponding Engineer, Nat Freese.

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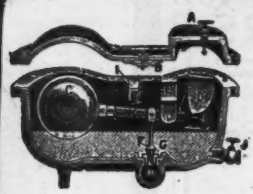
Deputy Supreme Chief Engineer, S. A. Bisbey, care of Cotton Compress and Warehouse Co., Galveston.

GALVESTON.

Galveston Council, No. 1, meets every 2nd and 4th Tuesday evenings at Engineers' Hall, S. W. Cor. Twenty-second and Strand Sts. Chief Engineer, Max Levy. Corresponding Engineer, A. L. Bradford, Union Depot.



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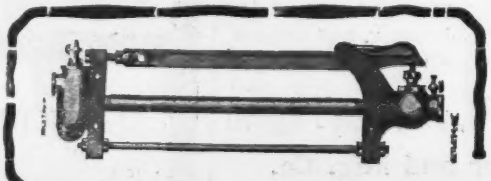

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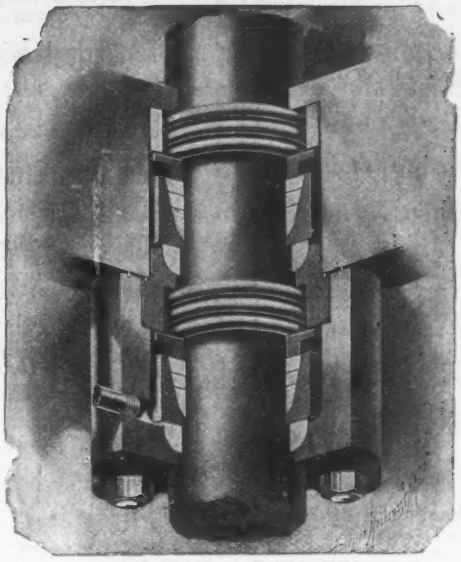

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Yours truly

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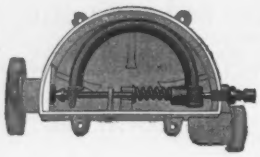

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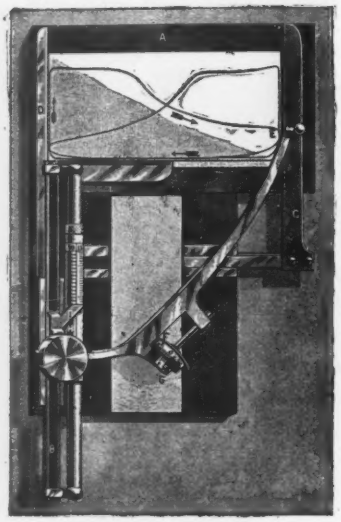
Improved Planimeter



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Complete for any Stroke

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CLEANS the tubes without admitting steam into them

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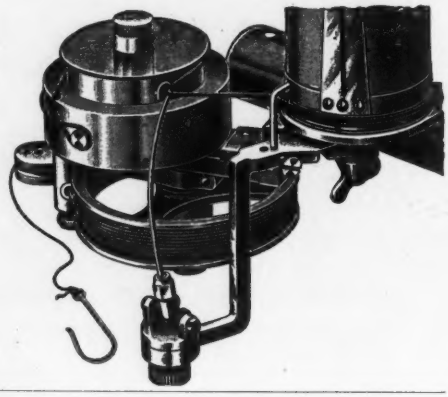
Attached to Bachelder Indicator with Ideal Reducing Wheel

Takes up the slack cord and puts it back where it belongs at the proper time.
No tangling or breaking of cord.



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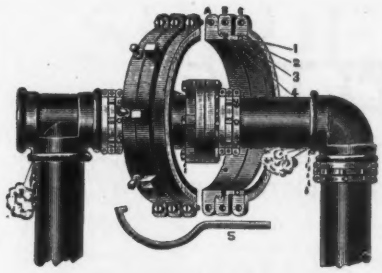

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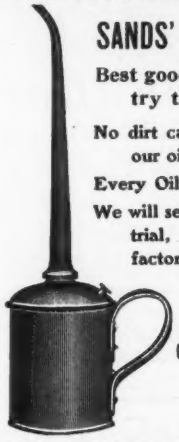

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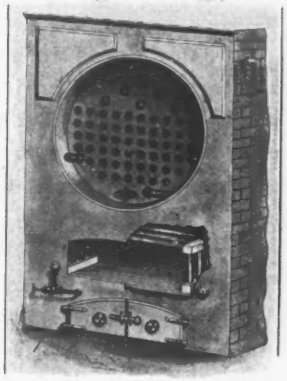

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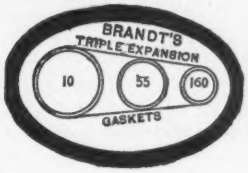

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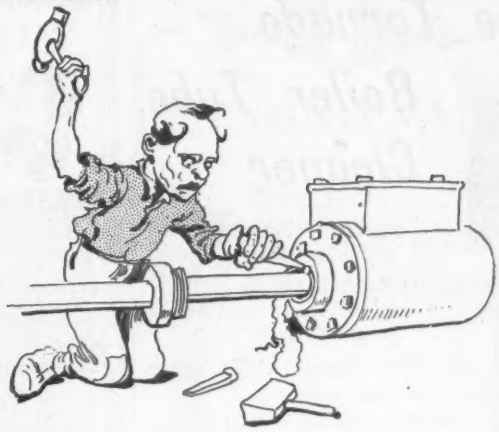

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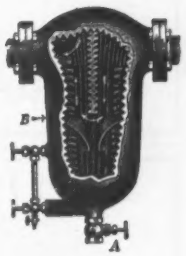

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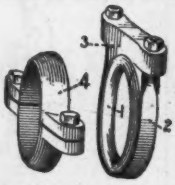

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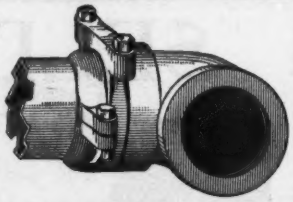

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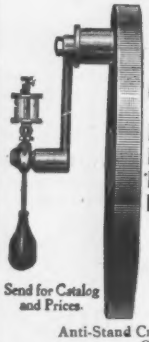

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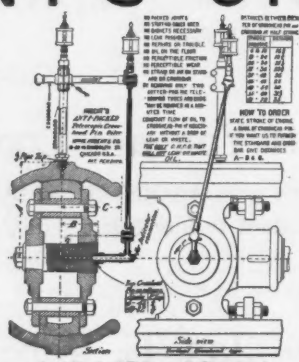

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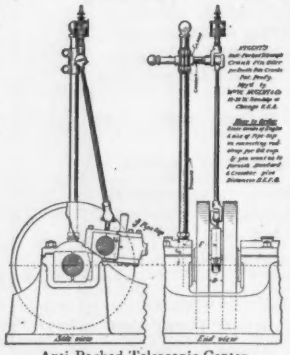

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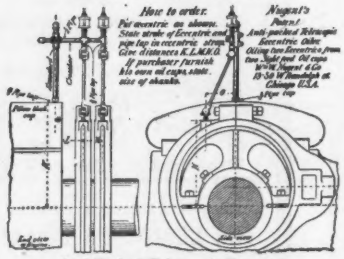

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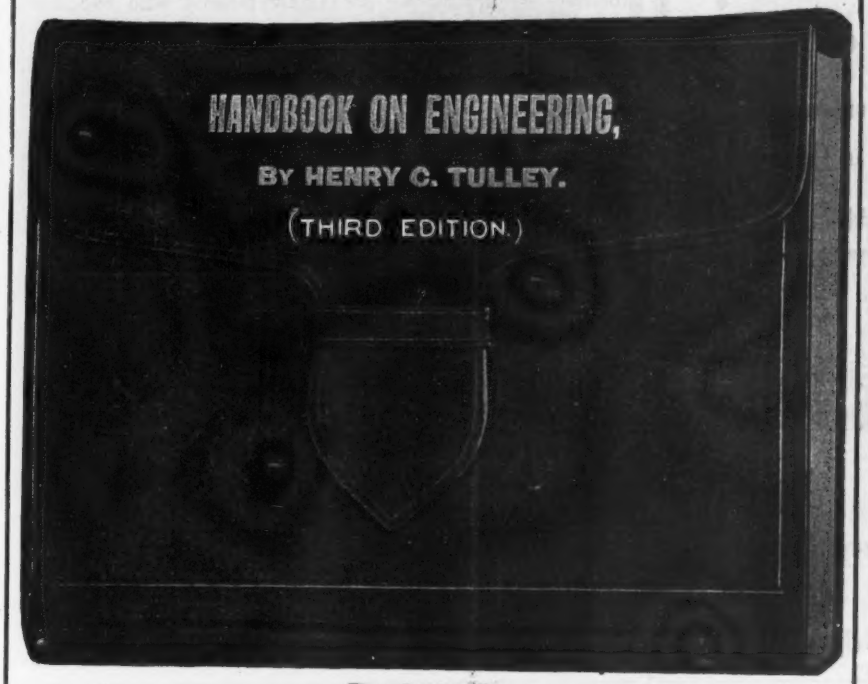

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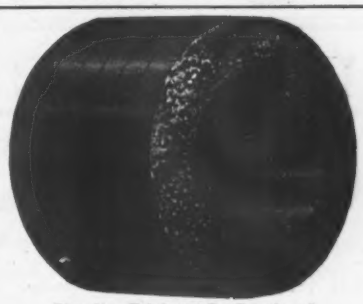

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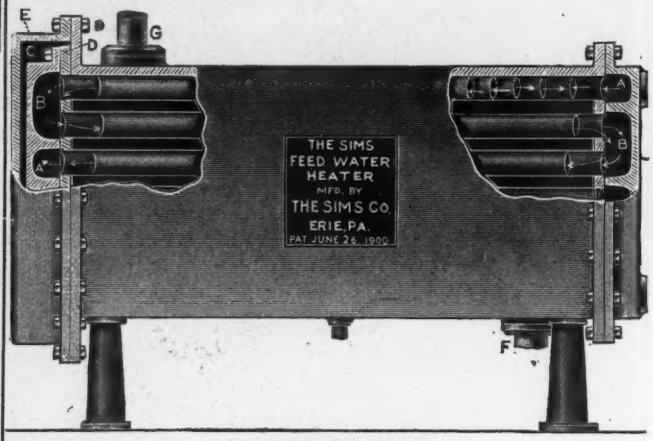

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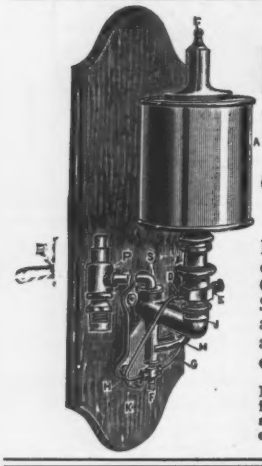

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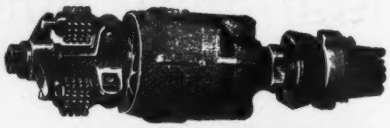

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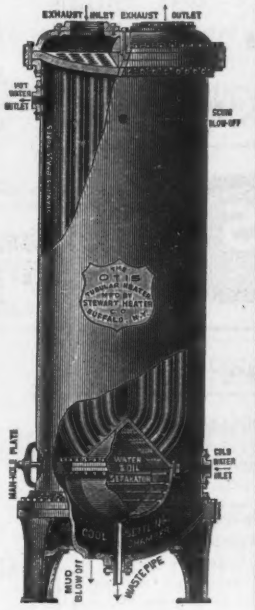

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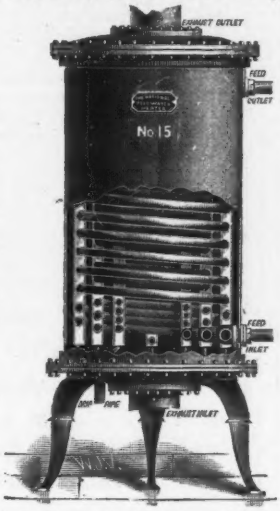

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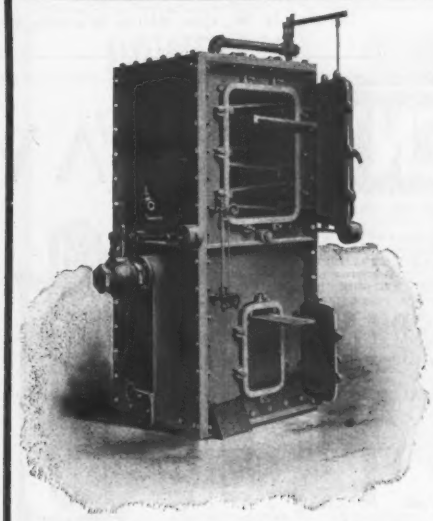

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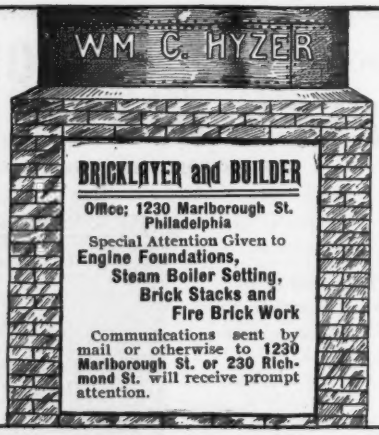
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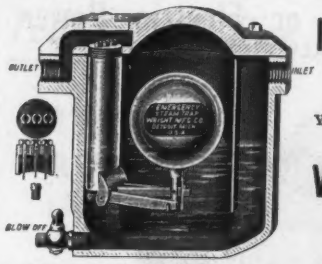

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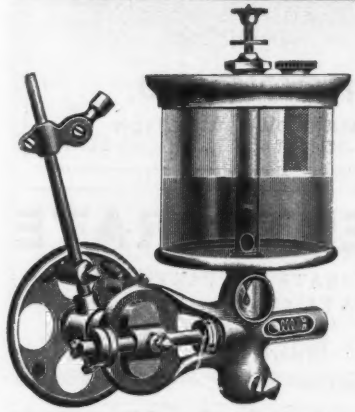

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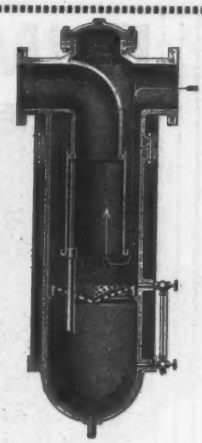

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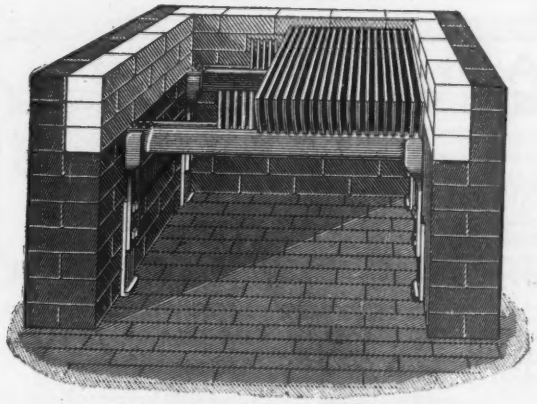

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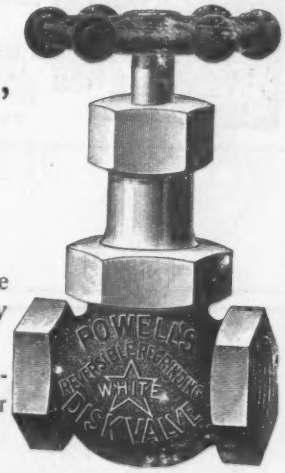

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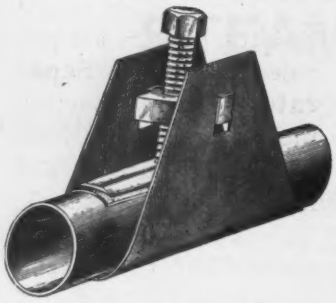

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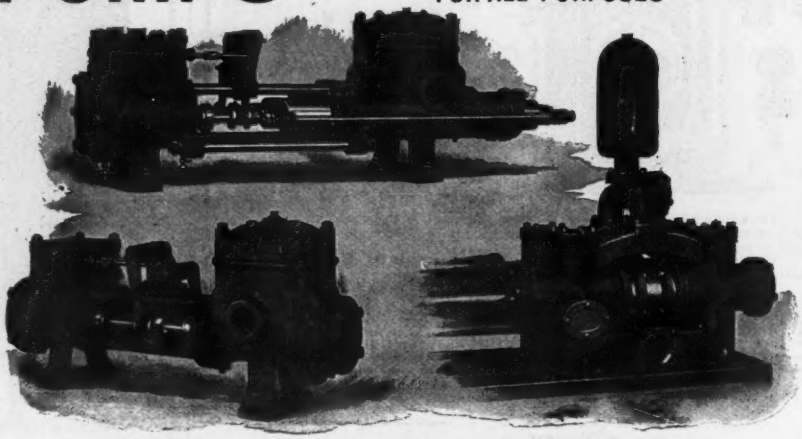

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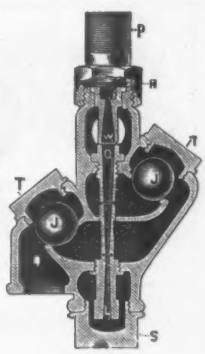

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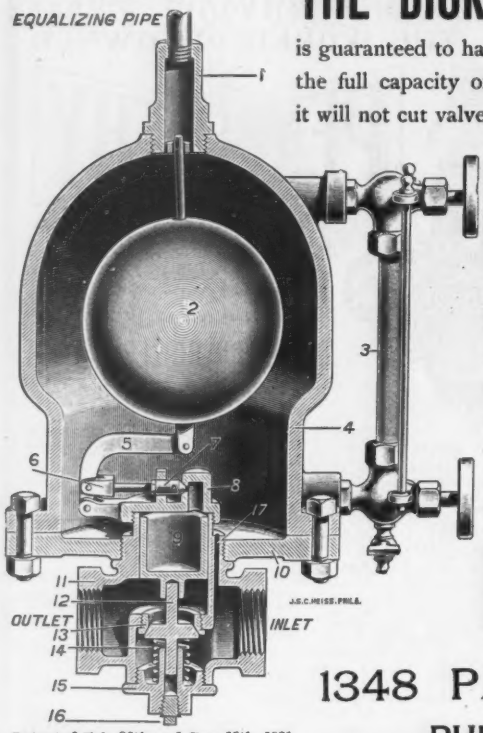

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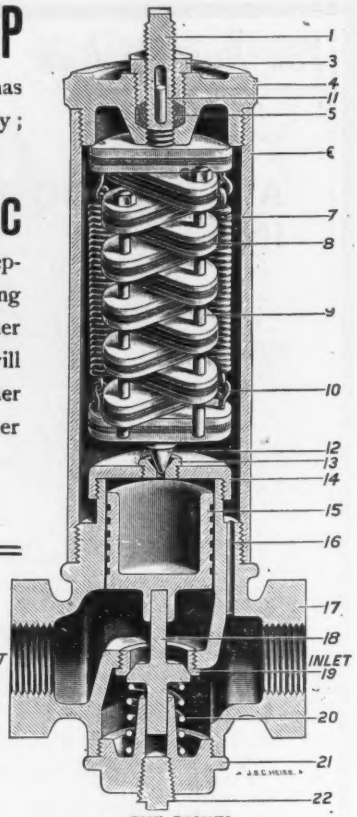

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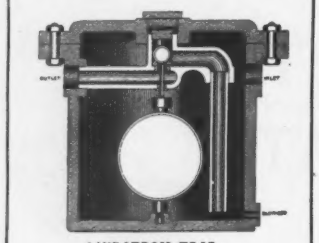

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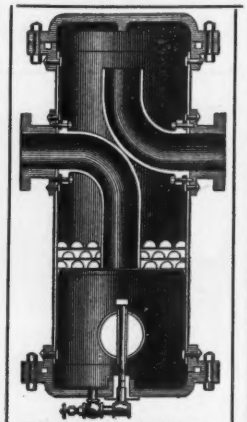

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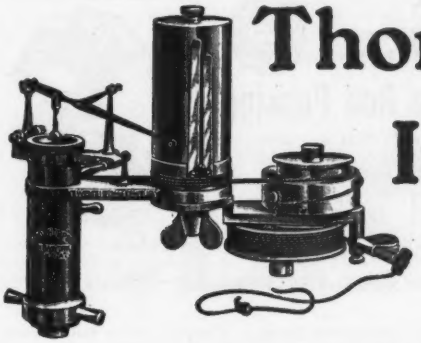

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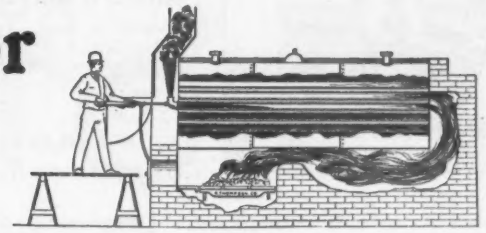

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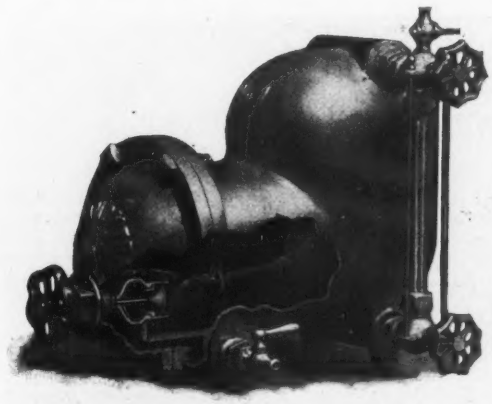

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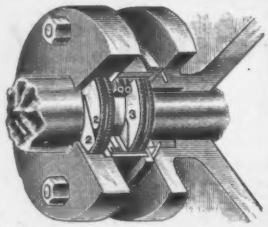

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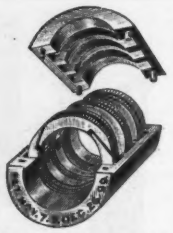

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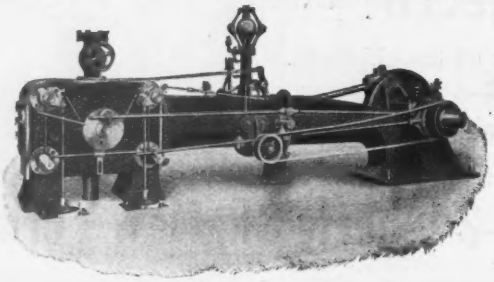

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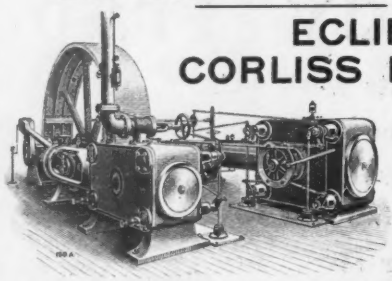

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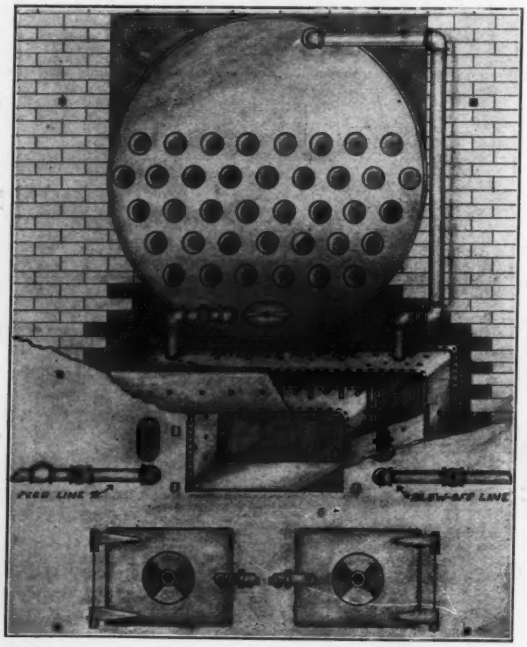

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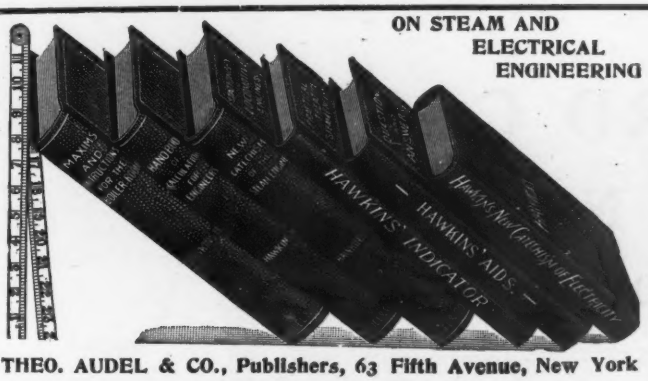

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dissolve, neutralize and prevent corrosion and scale incrustations.

They are not liquids, nor are they a fixed formula—but dry granulated powders, prepared expressly to remove the particular scale that has been received for analysis by us.

We make no charge for the analysis, and if you'll send a sample of scale from your boiler we will analyze it, send you certificate, and tell you the way to keep your boiler always clean.

Send sample to

GEO. W. LORD COMPANY

2238 North Ninth Street

PHILADELPHIA

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SAVES FUEL

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THE FUEL FAMINE

of the past six months has shown BOILER USERS the necessity for economizing on fuel cost, and present coal prices are not a small item. We guarantee to save you, through softening the water and removing the Boiler Scale with

KEYSTONE

TRI-SODIUM PHOSPHATE

13% if there is a scale of 1/16" and 50% if 3/8" thick. All engineers know the decreased cost of fuel when their boilers are free from scale and deposit. No shut down of Boilers for cleaning—purifies the feed-water thoroughly—has succeeded where all other Boiler Compounds have failed. Ask any chemist about the action of Keystone Tri-Sodium, and its effect on feed-water—ask us for our "Worth Knowing."

KEYSTONE CHEMICAL MFG. CO.

Camden, N. J.

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Send a Sample of Your Feed Water for Analysis Free

Send for our Booklet "WORTH KNOWING" Free to Engineers

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Repairs of Water Tubes. Boilers of all types a specialty. We have special tools for this purpose.
We keep constantly on hand ready for shipment 1000 horse-power. There can be no delay. **Send for Catalogue.**

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Gray-White, Semi-Steel Aluminum Alloy Castings. Mills and Pulverizers for Minerals, Cereals, &c.
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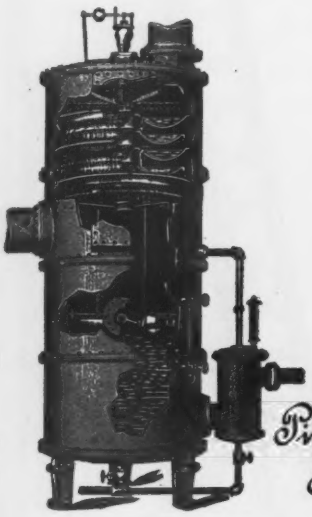

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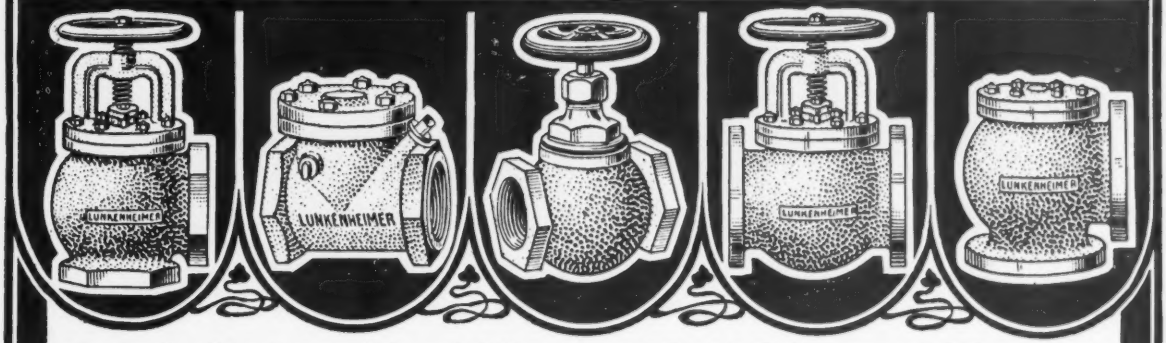
Iron Body, Brass Mounted, Globe, Angle, Cross, Check and Swing Check Valves



Are made of best materials and fully warranted. Made in screw and flange ends from two inches up. Endorsed and specified by intelligent steam users everywhere. Write for catalogue of Superior Brass and Iron Engineering Appliances.

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Sales Agents for Philadelphia: FORD & KENDIG CO., Nos. 1428-1432 Callowhill Street.
Engineers are invited to call and inspect a full line of our goods.

NONPAREIL CORK

IMPORTANT NOTICE

We have rebuilt our large factory at Camden, N. J., since being burned out some time ago, and are now ready to supply our Nonpareil Cork Covering for steam, water and brine pipes.

Many of our customers knowing the value of cork as an insulator, have placed orders with us for Cork Covering, to be delivered when plant was rebuilt. If you contemplate purchasing pipe covering for any condition of service, you should find out about cork before placing your order.

JOHN R. LIVEZEY
1936 SANSOM STREET
PHILADELPHIA

1208 E St., N. W., Wash., D. C.

The Nonpareil Cork Mfg. Co.
Gerken Building
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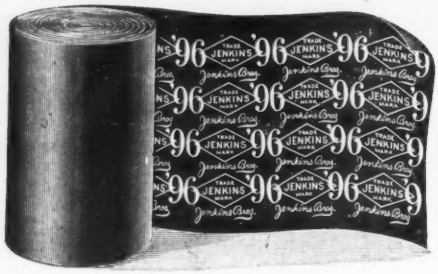
'96 Jenkins Standard '96 Packing '96

The Perfection of Joint Packing. Do not accept unless it bears our Trade-Mark as shown in the cut.

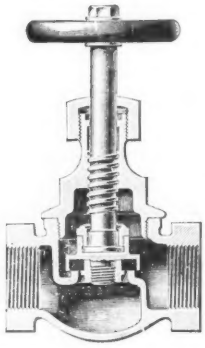


Use Jenkins '96 Sheet Packing on the worst joint you have, and if it is not what we claim we will refund the money.

JENKINS '96 PACKING has stood the most crucial tests under all conditions of service with steam, oils, acids, ammonia and the like, and in no case has it failed to make a perfect joint when properly applied. Can be placed in a joint either hot or cold, and will make joint instantly. Full steam pressure can be turned on at once when joint is made, it does not require to be followed up and will not blow out. It vulcanizes in place and forms a compound that will not rot or burn out, but will last as long as the metals which hold it. It joins with rough surfaces equally as well as when they are faced. **Jenkins Standard '96 Packing** weighs less than most joint packings. When compared with equal sizes of other packings sold at a lower price per pound, it will be found to cost less per square yard.

Jenkins Brothers' Valves

Designs, workmanship and materials of the highest standard throughout. Every valve inspected and tested before leaving the factory. Made in all styles and sizes, both brass and iron.



Jenkins Discs

Do not be deceived when you are offered discs "just as good" or better than the Jenkins, as many worthless imitations of our discs are on the market. We are the original manufacturers of this class of goods, and we have tried to maintain the high standard in which they are held by steam users throughout the world. Copper, Lead, Babbitt and all kinds of metal discs have been experimented with for the past twenty years, and in almost every instance, when under the action of steam, they become oxidized and hard, so that chip or scale getting between the disc and seat causes a leak, which necessitates regrinding. Insist on having the genuine Jenkins Discs; the difference in cost will not pay you to experiment. If you wish discs for any particular purpose, write to us; we can experiment cheaper for you than you can for yourselves. **Jenkins Discs will stand steam, oils or acids. We have special soft discs for cold water.**

Jenkins Brothers' Pump Valves

Adapted to every pumping requirement, these valves are especially suited for pumping hot water, syrups, beer and other destructive fluids; also muddy and gritty water. When rubber valves have been found useless, these valves have given entire satisfaction.

For mining and high-pressure service, also for elevator pumps, Jenkins Brothers' No. 88 Pump Valves are in use under 450 pounds pressure, and are proving themselves equal to every requirement.

We also manufacture a fine grade of Soft Rubber Valves for cold water and air service.

When ordering valves please state for what purpose you desire to use them.

Jenkins Brothers' Valves, Jenkins '96 Packing and Rubber Specialties received the highest Awards at the Pan-American Exposition

All the different specialties are stamped with Trade Mark.

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